HANDBOOK

CHEMICAL CONTROL OF RANGE WEEDS

U. S. DEPARTMENT OF AGRICULTURE, U. S. DEPARTMENT OF THE INTERIOR,
RANGE SEEDING EQUIPMENT COMMITTEE

REVISED MARCH 1959

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PREFACE

The control of 44 range weeds by use of chemicals is reported in this handbook prepared during 1958 for the Interagency Range Reseeding Equipment Committee. This report includes a revision of the recommendations given in 1955 for 16 weeds and in 1956 covering 22 additional range weeds.

The report is distributed to aid United States Department of Agriculture, United States Department of Interior, and other professional agricultural workers in the performance of their duties. Chemical control procedures are reported here as determined from published literature, first hand field experience, and personal correspondence. An attempt has been made to cite the source or to give references for all information presented. Personnel desiring to make public reference to data or statements in this handbook should refer to the individuals performing the original research that helped make this handbook possible.

These weedy range plants were selected on the basis of wide-spread occurrence and importance, and on feasibility of control by use of chemicals. A few of the weeds are also important on cropland. Rangeland should not be permitted to become a reservoir for perpetuating such weeds.

Some of the plants included in this handbook may have some value as forage or browse under certain conditions. The rancher or range manager will need to decide which plants are undesirable on his particular range and whether they should be controlled. The purpose of this handbook is to provide suggestions on the control of range weeds with chemicals. It is not a report on the seriousness of the plants as weeds nor a survey of economic losses resulting from their presence on the rangelands of the United States.

The Committee on Chemical Control of Range Weeds preparing this handbook has the following membership listed according to name, agency, and address:

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Chemical Names and Abbreviations

Used in this Handbook [1]

2,4-D	2,4-dichlorophenoxyacetic acid
2,4,5-T	2,4,5-trichlorophenoxyacetic acid
amitrol[2]	3-amino-1,2,4-triazole
PBA[3]	polychlorobenzoic acids
TCA	trichloroacetic acid
IPC	isopropyl N-phenylcarbamate
CIPC or Chloro IPC	isopropyl N-(3-chlorophenyl) carbamate
dalapon	2,2-dichloropropionic acid
monuron or CMU	3-(p-chlorophenyl)-1,1-dimethylurea
simazin	2-chloro-4,6-bis(ethylamino)-s-triazine
MCPA	2-methyl-4-chlorophenoxyacetic acid
fenuron	3-phenyl-1,1-dimethylurea
TBA	trichlorobenzoic acid
2-(2,4-DP)	2-(2,4-dichlorophenoxy) propionic acid
silvex or 2(2,4,5-TP)	2-(2,4,5-trichlorophenoxy) propionic acid
DNBP	4,6-dinitro o secondary amylphenol
ammate or AMS	ammonium sulfamate
DNC	3,5-dinitro o cresol
gal.	gallon
gpa	gallons per acre
gal./A	gallons per acre
psi	pounds per square inch
lb.	pound
lb./gal.	pounds per gallon
lb./A	pounds per acre
a.e.	acid equivalent
ahg	acid equivalent per 100 gallons
mph	miles per hour
WSA	Weed Society of America
SWC	Southern Weed Conference
NWCC	Northern Weed Control Conference
NCWCC	North Central Weed Control Conference
WWCC	Western Weed Control Conference

[1] The chemical names and abbreviations used in this handbook follow the report on nomenclature by the Terminology Committee of the Weed Society of America published in WEEDS, Volume 6, Number 1, pp. 73-74, January 1958.

[2] Amitrol is now the preferred common name for a chemical formerly designated in some reports as ATA, amizol, or amino triazol.

[3] Usually available as mixed isomers.

CONTENTS

WOODY PLANTS

CHEATGRASS BROME (Bromus tectorum L.)

Description and Occurrence

Cheatgrass brome, also known as downy chess, downy brome, broncograss, and junegrass, is an annual grass that has become widely established on western ranges since introduction from Europe. Principal disadvantages in having cheatgrass on the ranges are as follows: Low forage yield, short season when palatable, extremely high fluctuation in production from year to year, and high inflammability when dry.

Chemicals for Control

Chemical control of cheatgrass does not seem to be feasible on extensive areas at the present time. Chemicals may be justified, however, for controlling cheatgrass in fields used for seed production of perennial grasses, in firebreaks, in stopping spot invasion, in productive haylands, or in establishment of perennial grasses or browse plants on the range.

Rate, Volume and Carrier

CIPC at rates of 8 to 10 pounds per acre applied pre-emergence to prevent germination has been used successfully in control of cheatgrass brome. This treatment did not injure the perennial grasses such as blue grama and western wheatgrass (1, 2).

Chemical control of cheatgrass is possible from pre-emergence or seedling (2 leaves per plant) applications with IPC at 12 pounds per acre or with TCA at 8 to 10 pounds per acre (3).

IPC has successfully controlled annual bromegrasses on perennial grass seed fields with fall treatment of 3 to 4 pounds per acre applied no later than the middle of November (4). Precaution is necessary in treating perennial grass seed fields to avoid damage to the seed crop. It is recommended (5) that neither Chloro IPC or IPC should be applied at rates in excess of 4 pounds per acre on grass seed crops, and the Chloro IPC should not be used on either chewings or creeping red fescue.

Seedling perennial grasses are much more sensitive to herbicides than plants 1 year or older. Consequently, none of the herbicides mentioned here for control of cheatgrass brome should be used during the period of establishment of the perennial grasses.

Dalapon and monuron are two recent chemicals being tested (6) in cheatgrass control but dalapon is not safe to use selectively in pastures and ranges because of injury to other grasses. Dalapon (sodium salt) was applied experimentally at rates of 3, 6, and 9 pounds acid equivalent per acre for control of cheatgrass in alfalfa in Michigan (7). The 3-pound rate gave good control, and the 6- and 9-pound rates were excellent. In Montana (9) lower rates of dalapon (2 and 4 pounds per acre) were applied to cheatgrass brome as seedlings emerged. This treatment was effective for chemical fallow purposes. A 5-pound rate was required to control cheatgrass brome after plants had become established.

Monuron (trade names Karmex W. and Telvar W.) applied in the fall at rates of 6 and 9 pounds per acre gave 100-percent control of cheatgrass (8). A 3-pound rate gave 80-percent control. Spring application of monuron, simazin, amitrol, and dalapon at different rates gave less satisfactory control than the fall treatment with monuron. This experiment was conducted along State highways in eastern and central Oregon where cheatgrass brome presents a serious fire hazard to grain fields.

Time of Application

Best control of cheatgrass has been obtained when chemicals have been applied at the time cheatgrass seedlings emerge. This time is usually in the fall if moisture is available for germination and may range from pre-emergence to the second-leaf stage.

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Donald R. Cornelius

FOXTAIL BARLEY (Hordeum jubatum L.)

Description and Distribution

Foxtail barley is an introduced perennial grass which now infests all except the southern States east of the Mississippi River. It ranges as far north as Alaska and south to Mexico. It is a coarse grass with a bunch habit of growth and grows from 6 to 24 inches in height. The heads consist of numerous one-seeded spikelets with two associated rudimentary spikelets, all of which are awned. It is commonly found in low, wet spots of meadows and irrigated fields, on the edges of ponds, streams and irrigation ditches and in swampy, alkaline flats. It begins growth early in the spring and is often headed by the time forage crops are ready for cutting. The large number of barbed awns which can cause injury and even death to livestock, particularly sheep, consuming hay of which it is a part is the chief cause for objection to its presence (3).

Chemicals

In a series of tests by Cords (1) IPC (isopropyl phenyl carbamate), CIPC (isopropyl N-(3-chlorophenyl) carbamate), TCA (trichloroacetic acid, sodium salt) showed no promise for controlling foxtail barley. The sodium salt of dalapon (2, 2-dichloropropionic acid) appeared to be the only effective chemical of those tried in killing foxtail barley.

Rate of Application, Volume, and Carrier

Forty-eight lbs. of dalapon per acre in water at 50 gpa gave complete kills (1). Lower rates of 16 and 32 lb/A allowed some survival. A combination of 30 lbs. of dalapon and 4 lbs. of amino triazole per acre also gave a satisfactory kill. Heavy grazing accompanying the treatments was also found to add to the effectiveness of chemical treatment.

Time of Application

Applications were made in both May and July. Complete kills were obtained in both months of treatment, although the earlier month is recommended because of the early growth habit of foxtail barley.

General Considerations

Treatments with dalapon also kill most of the desirable forage grasses in the treated area. Establishment of a suitable forage species such as tall wheatgrass or tall fescue, together with proper fertilizer application, may be a practical method of converting high water table areas from foxtail barley patches into profitable pastures (2). From the preliminary work which has been done, it appears that a combination of cultural, management, and chemical treatments may ultimately prove to be the most economical method of controlling foxtail barley.

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W. C. Robocker

MEDUSA HEAD (Elymus caput-medusae L.)

Description and Occurrence

Medusa head was introduced from Europe and has spread through considerable rangeland in Idaho, Oregon, Washington, and California. Extremely low palatability makes this weedy annual grass very undesirable. Aggressiveness has been demonstrated at numerous locations where fairly dense stands of cheatgrass have been invaded by medusa head.

Chemicals for Control

Research work with chemicals has not progressed far enough for specific recommendations to be made for field-scale control measures. Preliminary testing of chemicals (1) has shown dalapon to be superior to IPC, CIPC, monuron, and Urab.

Rate, Volume and Carrier

Dalapon was used at rates from 1/2 pound to 16 pounds acid equivalent per acre (1). Four pounds or more were required to eliminate medusa head. Tests were conducted in Coast Range mountains, elevation 500 to 2,000 feet, in northwestern California. No snow cover occurs in this area, and the medusa head makes slow growth throughout the winter.

Dalapon has been applied experimentally at the following rates: 0.35, 0.70, and 1.40 pounds of acid equivalent per acre. The 1.40-pound rate gave good control of medusa head (2). Tests were conducted on a plateau area in Modoc County, northeastern California, at an elevation of 5,000 feet with average annual precipitation about 12 inches. Snow cover and low temperatures occur through most of the winter at this location.

Experimental work (4) with dalapon in Idaho applied April 27, 1956, gave 47 percent control for the 1-pound rate, 90 percent for the 2-pound rate, and 97 percent for the 4-pound rate. Also, in Idaho, tests were established in April 1955 with herbicides applied at 0, 2, 4, 6 and 8 pounds per acre (5). Dalapon at all rates, from the 2-pound rate up, gave 100-percent control. Amitrol gave 100-percent control at the 6-pound rate and about 90 percent at the 2-pound rate. IPC and CIPC were less effective.

Monuron applied to medusa head in southwestern Idaho at rates from 1 to 80 pounds per acre gave complete eradication only with the 40- and 80-pound rates (3).

These limited results in chemical control of medusa head would not indicate feasible control methods for use on extensive areas. However, on spot invasions into new range areas treatment with 4 pounds of dalapon with a wetting agent in 20 gallons of water per acre would seem to be warranted.

Time of Application

For best results with dalapon, spray in the spring when medusa head is 3 to 6 inches tall, is still in the leaf stage, and before the boot stage has been reached.

General Considerations

Great precaution should be taken to find this aggressive annual weedy grass in the earliest possible stage of invasion in order for chemical treatment to be most practical.

Chemical treatment of a few small patches of medusa head may be practical, while spraying of extensive areas may not be feasible.

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Donald R. Cornelius

BITTERWEED (Hymenoxys odorata DC.)

Species, Description and Distribution

Bitterweed is a member of the composite family. It is an annual, usually much-branched plant, that varies in height from a few inches to about 2 feet according to environmental conditions. Each of the ascending stem branches terminates in a yellow-flowered head. The flower heads are made up of many small flowers, and under normal growth conditions each head produces from 25 to 75 seeds. Seedlings or older green plants may be found at almost any time of the year in certain localities, but most growth is from early spring to early or midsummer. If climatic conditions are favorable, growth may start as early as December. The plant has a bitter taste and the leaves give off an aromatic odor when crushed.

This species (Hymenoxys odorata) is related to Pingue (Hymenoxys richardsoni Hook.) another poisonous plant of the same genus which causes heavy death loss of sheep on ranges of Colorado, Arizona and New Mexico.

Bitterweed is widely distributed in Texas and extends to California and from Kansas south into Mexico. It occurs on overgrazed or disturbed range lands.

Chemical Control

Herbicidal control has been practiced with varying degrees of success. The best kills to date have been obtained with the esters of 2,4-D. Water solutions at concentrations of 0.2 percent applied as wetting sprays or a spray of 1 pound of acid equivalent of 2,4-D in 25 to 50 gallons of water per acre applied with power equipment has given good kills.

Time of Application

Spray before flowering period. Mature bitterweed plants and those growing on dry habitats are difficult to kill with herbicides.

General Considerations

Animals poisoned: In general sheep are readily poisoned by eating large amounts of bitterweed, and even cattle losses have occurred in certain heavily infested areas. Sheep poisoning by bitterweed has been very common in the Edwards Plateau region of Texas in the winter and early spring before green forage was available.

Poisonous nature and symptoms: From studies made in Texas it is apparent that bitterweed is more toxic during drouth years than under conditions approaching normal rainfall. It has been determined that about one pound of green immature bitterweed will kill sheep if eaten during a period of two days.

The most common symptoms of bitterweed poisoning are loss of appetite, cessation of rummation, depression, indications of abdominal pain, bloating, and green regurgitated material about the mouth and nose. Post-mortem observations will show congestions of the lungs as well as other internal disturbances.

Control and management: There is no medical cure for severely poisoned animals therefore, as soon as animals show symptoms of poisoning they should be removed to clean or desirable pastures or put on feed. Good condition range is the answer to controlling bitterweed.

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Vernon A. Young

DEATH CAMAS (Zygadenus venenosus S. Wats; Zygadenus paniculatus [Nutt.] Wats; Zygadenus elegans Pursh.)

Description and Occurrence

Several species of death camas are poisonous to livestock.

Death camas is a member of the lily family. It has grasslike leaves that grow from a deeply placed bulb. The bulb often has a dark skin and is odorless. The flowers are cream colored. Plant height is 6 to 20 inches.

Chemicals for Control

Both 2,4-D and 2,4,5-T have been used in attempts to control death camas. It is slightly resistant to 2,4-D and even more resistant to 2,4,5-T.

Rate, Volume and Carrier

Fair kills can be obtained with 2,4-D ester at 3 pounds per acre. Re-treatment the second and third year will give complete control. Either oil or water can be used as a carrier. If water is used as a carrier, a detergent should be added to give a more thorough wetting of the slick leaves. Three gallons of oil per acre or 10 gallons of water should be used. Less water can be used if the particular sprayer being used will give a uniform coverage of the leaf surface. It should be noted, however, that good kills of Zygadenus paniculatus have been obtained in southern Idaho using 2 pounds of 2,4-D ester per acre (1).

Time of Application

The best control has resulted from spraying during the early bud stage.

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   Ester formulations superior to amine type of 2,4-D. Three pounds ester controlled virtually all old plants after one year's application. 2,4,5-T and 2,4-D are not as effective as 2,4-D alone.

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Karl G. Parker

WESTERN FALSE-HELLEBORE (Veratrum californicum Durand)

Description and Occurrence

Western False-hellebore occurs on mountain meadows of the 11 western States. Low palatability and competition with more valuable forage plants for grazing on soils otherwise potentially high in production make this plant undesirable on rangeland. It contains a poisonous property, but livestock are seldom poisoned under normal grazing conditions. The plants are strong perennials, 3 to 8 feet in height, with a short, thick rootstock.

Chemicals for Control

The ester form of 2,4-D has been effective in controlling western false-hellebore (1, 2). Diesel oil has also been used as a contact herbicide to eradicate this weed (4).

Rate, Volume, and Carrier

Butoxyethanol ester of 2,4-D at 2.6 pounds acid equivalent in 160 gallons of water per acre gave 93 percent kill of plants in California (1).

The herbicidal properties of 2,4-D (isopropyl and butyl esters mixed) and amitrol were compared for control of western false-hellebore in Oregon (2). A rate of 3 pounds per acre of active ingredient of each herbicide was sprayed in water at 50 gallons per acre with a boom spray at 50 psi. The control with 2,4-D was 95 percent and with amitrol 65 percent.

A test using 4 pounds acid equivalent of isopropyl ester of 2,4-D per acre and retreatment at same rate 1 year later gave excellent control in Washington. The density of false-hellebore was only 6 percent of the density before spraying (3). All these tests may be considered preliminary with respect to development of recommendations to be prescribed for general use. The results are encouraging, but more experimental work with chemicals is needed. Results to date indicate some follow-up retreatment will be necessary for complete control. This retreatment may be accomplished by use of hand sprayer on small scattered spots that escape and survive.

Diesel oil having 27 A.P.I. gravity satisfactorily controlled western false-hellebore as an individual plant treatment (4). Lighter diesel oil up to 32 A.P.I. gravity killed the plants but was less effective than the heavier oil. A regular oil can or a pressure sprayer of the back-pack type with nozzle removed to give a small stream was used to pour the diesel oil into the funnel-like collars of the leaves. One gallon of diesel treated about 320 plants. Approximately 1000 plants were treated per man-hour.

Time of Application

Spray with selective herbicides should be applied after most of the leaves are expanded but before bloom appears. In California this stage occurs about mid-June. The diesel oil treatment was most satisfactory when applied at the time the plants began to bloom. Earlier application was not so successful because young plants were too small and difficult to find.

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Donald R. Cornelius

HALOGETON (Halogeton glomeratus (M. Bieb.) C. A. Mey.)

Description and Distribution

Probably no range weed has received such widespread attention as halogeton following discovery of its poisonous properties. There has been considerable work on chemical control of this plant, but as yet no entirely satisfactory agent has been discovered. This has been due largely to:

1. The prolific production of the easily disseminated winged, black seeds, having a short period of dormancy and high germination.
2. Germination from early spring through midsummer under favorable conditions.
3. A rapidly developing resistance to effects of chemicals with maturation of the plant.
4. The pronounced dormancy of the wingless, brown seed, although recent investigations have indicated that the brown seed may be of no importance in survival of an infestation of halogeton (5).

Halogeton infests at present, in varying degrees, an estimated 11 million acres in the States of Nevada, Utah, Idaho, Montana, Wyoming, Colorado, California, and Oregon. The area of infestation appears to be increasing, particularly on denuded and depleted ranges.

Early in 1955, a committee comprised of interested State and Federal agencies prepared a guide (3) for the use of supervisory and control personnel on killing halogeton with chemicals. The introduction, in part, states: "Halogeton control with presently recommended chemicals is comparatively expensive and should be restricted mainly to isolated spot infestations where complete kills with resultant eradication is feasible. Other control measures such as range reseeding on adapted sites, forage development projects, and good range management have proven to be more practical in controlling large halogeton infestigations in range areas."

Chemicals

The heavy or low volatile esters of 2, 4-D, such as propylene glycol butyl ether ester or butoxyethanol ester, should be used for post-emergence sprays. Silvex (2-(2, 4, 5-trichlorophenoxy) propionic acid) and 2, 3, 6-trichlorobenzoic acid have shown some promise for pre-emergence control, but recommendations are not yet available (2). Where the economics of control warrant the use of soil sterilants, borates, borate-chlorate mixtures, sodium chlorate, and urea compounds may be used.

Rate of Application, Volume and Carrier

Two lb/A of 2, 4-D in 20 gallons of water or 1 lb/A in 10 to 15 gallons of diesel or aromatic oil are recommended for early application. For later application, 4 lb/A in 20 gallons of water or 2 lb/A in 1-to 15 gallons of oil. (The foregoing rates are in lb/A of acid equivalent of 2, 4-D.) The following rates per square rod are recommended as a guide for the soil sterilants (1); Borate, 20-35 pounds; borate-chlorate mixtures, 8-15 pounds; sodium chlorate, 5-10 pounds; monuron and related urea compounds, 1/4 to 1/2 pound.

Time of Application

The lower rates of 2, 4-D should be applied in the pre-flowering stage; the higher rates should be used when halogeton plants have begun flowering. Soil sterilants are preferably applied in late fall or in early spring.

General Considerations

The successful eradication of halogeton plants with chemicals depends on the following procedures and precautions: proper timing as related to the development of the plant, adequate concentration and coverage of herbicide, and follow-up treatments when necessary to prevent maturation of late-germinating or partially killed plants. It should also be remembered that spray applied to kill halogeton will also kill other broad-leaf vegetation, and indiscriminate use will only add to the density and spread of the weed in many cases. As the development of plant progresses from the vegetative to reproductive or post-flowering stage of growth, resistance to chemicals increases rapidly, and in order to insure a satisfactory kill, the rate of application should be increased accordingly. An experiment using aerial application of 2,4-D in Nevada at a rate of 2 lb/A indicated that aerial application is not a feasible method of obtaining satisfactory control in that 17 percent of the plants survived and produced seeds (4).

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W. C. Robocker

RUSSIAN KNAPWEED (Centaurea picris Pall. [C. repens L.])

Description and Occurrence

Russian knapweed was introduced from the Caspian region of southern Russia into the United States with Turkestan alfalfa seed. It now occurs as a serious pest in Turkestan, South Africa, Australia, and the United States.

The creeping perennial rootstocks often extend to a depth of 2 to 4 feet. Plants are bitter and unpalatable to livestock.

Chemicals for Control

The amine form of 2, 4-D is most generally recommended for use in spraying. Soil sterilants that have proved to be effective are sodium chlorate, CBM, Chlorax and BDM.

Rate, Volume, and Carrier

Two applications per year of an amine of 2, 4-D at rates of 6 pounds per acre per spray treatment will control 90 percent of the original stand after 1 year (2). Early spring application of 40 to 80 pounds per acre of an amine of 2, 4-D with spot treatment of any regrowth will also control this weed (2).

Foliage applications of amitrol, PBA, and butoxy ethanol ester of 2, 4-D were compared on Russian knapweed in Colorado (4). No control was obtained with amitrol up to 8 pounds active ingredient per acre. The 2, 4-D was one of the most effective treatments with 90-percent control at 4 pounds per acre.

Treatments with soil sterilants on the east side of Fresno County, California, where soil is light-textured and annual rainfall is from 12 to 16 inches were 95 to 98 percent effective (3). Rates of application per 100 square feet for different chemicals are as follows: sodium chlorate, 1-1/2 pound; CBM, 3 pounds; and chlorax liquid, 3/5 gallon. Two treatments, each at these rates, are required. In the west side of Fresno County the soil is heavy-textured and rainfall is from 4 to 7 inches each season. This rainfall is not enough to cause sufficient penetration of the sterilizing agents into the heavy soil. Here the successful treatment recommended is 10 pounds sodium chlorate per square rod, followed by flooding with 10 to 12 inches of water. Roadside treatment recommended is 6 pounds CBM or 1-1/5 gallons chlorax liquid to each 100 square feet (3). The borate compounds are safe from fire, but sodium chlorate is a fire hazard.

Time of Application

Spraying with 2, 4-D should be done just before bud formation (mid-June) and the second application made to standing injured weeds and regrowth, about 60 days later (2). The first treatments with soil sterilants are applied in Fresno County, California, in December and second treatment in February (3).

General Considerations

Great care should be taken in obtaining clean seed for range reseeding projects. Russian knapweed seed is especially well adapted for spread through alfalfa seed. It occurs in about 1 percent of all non-certified alfalfa seed samples analyzed by the Wyoming State Seed Laboratory (1).

References

1. Bohmont, D. W. July 1953. Weeds of Wyoming. Wyo. Agr. Expt. Sta. Bul. 325: 160 p.

2. _____. April 1955. Weed Control in Wyoming. Wyo. Agr. Expt. Sta. Circ. 59: 11 p.

3. Polson, J. I. 1954. Soil sterilizing materials as used on Russian knapweed (Centaurea repens) in Fresno County. Calif. Weed Conf. Proc. 6: 49-51.

4. Thornton, Bruce J. 1958. Results of foliage treatments of Russian knapweed (Centaurea picris) with animo triazole, chlorinated benzoic acid, and 2,4-D formulations. Res. Prog. Rpt. Western Weed Control Conference, p. 11.

Donald R. Cornelius

SAGEBRUSH LARKSPUR (Delphinium megacarpum Nels. and Macbr.)

Description and Occurrence

This species of Delphinium is similar to other species in the group called low larkspurs. It most commonly grows to a height of about 12 inches, but in wetter years may reach a height of 2 feet. It is poisonous and is often responsible for cattle deaths in the spring.

The spraying recommendations given presumably apply to other low larkspurs, but must not be extended to the tall larkspurs.

Chemicals for Control

2,4-D ester at 1 lb/A was more effective throughout the season than 2,4,5-T at 2 lb/A.

Rate, Volume, and Carrier

When larkspur was fully emerged 2,4-D killed 87% and 93% of the plants respectively at 1 and 2 lb/A. At full basal leaf development (two weeks after fully emerged) kills were 74 and 83% respectively at 1 and 2 lb/A of 2,4-D. Solution volumes of 3 and 6 gal/A gave equal kills.

Apply 2,4-D ester at 1 to 1-1/2 lb/A in water (or other solvents if preferred) at a total volume of 3 to 5 gal/A. The recommended rates for big sagebrush should be used if simultaneous sagebrush control is desired.

Time of Application

The effectiveness of 2,4-D dropped consistently from a high of 93% at 2 lb/A on April 20 to a low to 28% on July 8. It was observed that plants in flower when sprayed were not killed. Thus early spraying is required. Spray before larkspur flowering stems are 2 inches high.

With careful timing a good reduction in larkspur may be obtained by applications intended primarily for big sagebrush control. The application should be made before larkspur flower stems reach a height of 2 inches, and shortly after sandberg bluegrass has headed out. It appears that the simultaneous kill of sagebrush and larkspur can be obtained at elevations below 4,600 feet. At higher elevations the coincidence of susceptible development may not occur, because the flowering development of larkspur appears to be controlled by day length. Thus larkspur susceptibility may be lost before big sagebrush is growing rapidly.

References

1. Hyder, D. N., Sneva, F. A., and Calvin, L. D. 1956. Chemical control of sagebrush larkspur. Jour. Range Management 9 (4): 184-186.

D. N. Hyder

LOCO (Astragalus sp. and Oxytropis sp.)

Description and Occurrence

Loco is a general term applied to certain plants of the pea family. They have compound leaves and grow in tufts with a large taproot. It occurs throughout the western arid and semi-arid states.

Chemicals for Control

Apparently, under favorable conditions, most of the important species can be controlled satisfactorily with the ester form of 2, 4-D. 2, 4, 5-T is not as effective as 2, 4-D on loco.

Rate, Volume and Carrier

Two pounds per acre of an ester of 2, 4-D in water or oil.

Time of Application

Spray when the plants are in bloom. Much better kills are obtained when there is abundant soil moisture.

General Considerations

Loco has long been a problem on range, especially where early spring feed for livestock is lacking and it is necessary to turn livestock on range. In dry years, it is often one of the first plants to "green up".

Not all loco weeds are poisonous. Some of the poisonous species are white point or silvery loco (Oxytropis sericea Nutt.), Lambert crazyweed (O. lamberti Pursh.), spike crazyweed (O. macouni Greene), Rocky Mountain crazyweed (O. saximontana Nels.), timber poisonvetch (Astragalus convallarius Greene), blue or specklepod loco (A. lentiginosus Dougl.) and wooly loco (A. mollissimus Torr.). Two grooved poisonvetch (Astragalus bisulcatus /Hook/ Gray) is a selenium bearing plant capable of poisoning livestock.

The many different kinds of loco in the West make loco control on range a bit complicated. Different species give different results to treatments.

In parts of the West, 3 pounds of 2, 4-D ester obtained nearly a 70 percent kill. There was some additional benefit due to kill of other unpalatable plants, such as fringed sagewort and phlox. Grass production was definitely increased.

White point loco is the most difficult to kill. Closely related plants of this species in other areas respond well to treatment.

References

1. Bohmont, D. W. 1952. Chemical control of poisonous range plants. Wyoming Agricultural Experiment Station Bulletin 313.

100 percent control of loco can be obtained by applying 2, 4-D at 2 pounds per acre during bloom stage. Either ester or amine formulations can be used. Under good conditions, one pound per acre of 2, 4-D gives good control. Where moisture is limited, higher rates of 2, 4-D are recommended.

2. Payne, G. F., and Warden, R. L. 1952. Chemical control of white loco. Montana State Agricultural Experiment Station Report No. 10.

Seventy percent kill was obtained with 3 pounds per acre of 2, 4-D heavy ester in water; 4 pounds gave 72 percent kill; 2 pounds of 2, 4-D ester in water gave 27 percent kill. Apply in bloom stage. Cost of application considered prohibitive.

Karl G. Parker

LUPINE (Lupinus sp.)

Description and Occurrence

Lupine is a member of the pea family. Flowers are in spikelike arrangements, and are blue, pink, yellow or white. Leaves are composed of several leaflets which radiate from the end of the leaf stem.

Lupines are of most importance in foothill and mountain ranges. Seldom are infestations heavy enough in plains areas to require control.

Chemicals for Control

Lupines are generally quite sensitive to the ester of 2, 4-D applied either in oil or water.

Rate, Volume and Carrier

Two pounds of 2, 4-D ester per acre in 3 gallons of oil or 10 gallons of water, after plants have reached a height of 5 inches and before full bloom (2) should obtain about an 80 percent kill the first year. With follow-up treatment on succeeding years, effective control can be attained. Less than 10 gallons per acre of water can be used, if uniform coverage is attained.

Time of Application

Growing conditions directly affect the efficiency of spray applications. Better kills are obtained when moisture and temperature permit rapid growth of plants.

General Considerations

Some lupine are not poisonous. However, since loss of 600 head of sheep have been suffered in one day where sheep were "dogged" through a lupine patch, any lupine species should be suspicioned of being poisonous unless it has been proved experimentally to be non-poisonous.

Marsh and Clawson listed L. argenteus Pursh. as the most poisonous species; L. angustifolius, L. leucopsis, L. leucophyllus Dougl. were also listed as toxic.

All of the aerial parts of the poisonous species are dangerous. The seeds are most poisonous, then the pods, and leaves, in that order.

Control will be most profitable on infestations where shipments of sheep are unloaded for trailing and where sheep are of necessity moved along rapidly.

References

1. Marsh, C. D., and Clawson, A. B. 1916. Lupines as poisonous plants, USDA Bul. 405. Prof. paper, pp. 28-30.

   Listed lupines: Lupinus albus, L. angustifolius, L. leucopsis and L. leucophyllus as toxic; with L. luteus as "less toxic"; and with L. argenteus as most poisonous species in America.

2. Hyder, Donald N. (Burns, Oregon) 1955. Squaw-Butte Harney Experiment Station. Special notes prepared for Karl G. Parker.

3. Parker, Karl G., and Atkins, Ed. Montana State College. 1955. Unpublished field notes.

Four rates of isopropyl ester of 2,4-D in water at 10 gallons per acre were applied in early bloom stage, July 1, 1955. Number of plants counted June 9, 1955, showed the following kills:

1 pound per acre-----65.2 percent kill
1.5 pounds per acre--73 percent kill
2 pounds per acre----79.6 percent kill
Untreated plot check

4. Bohmont, D. W. 1952. Chemical control of noxious range plants. Wyoming Experiment Station Bulletin 313.

Two pounds 2,4-D ester gave 80 percent kill with one treatment in bloom stage. Two years treatment gave 90 percent control.

5. Mueggler, Walter F. 1952. Effects of several chemicals on tall larkspur and associated with tailcup lupine. Intermountain Forest and Range Experiment Station, Ogden, Utah, Research Report. No. 4.

Ninety percent kill of lupine sprayed with 2,4-D ethyl ester and 2,4-D butoxy ethanol ester in eastern Idaho. Concentrations in excess of 2 pounds per acre did not give appreciable increased kill. Early application best.

Karl G. Parker

MULE-EAR (Wyethia amplexicaulis Nutt. and W. helianthoides Nutt.)

Distribution and Description

Mule-ear, also known as green dock and black sunflower, is a tufted perennial with smooth, waxy leaves and a thick taproot. It reproduces only by seed, yet is aggressive and highly competitive.

Mule-ear is common throughout most of the mountainous and foot-hill areas of the Western United States and occurs in dense stands. It is found most commonly on open flats, parks, broad ridges and gentle slopes.

Chemicals

Esters of 2,4-D

Rate, Volume and Carrier

Good results have been obtained with 2 pounds acid equivalent per acre of the above chemical in 10 gallons of water applied by ground rig, or 3 gallons of diesel oil applied by air. The ethyl, butyl, and butoxyethanol esters of 2,4-D have been successfully used.

Time of Application

Best results are obtained from immediate pre-bloom to half-bloom stage.

General Considerations

Ranges sprayed to eradicate wyethia should be rested from grazing for at least two seasons following spraying.

References

1. Evanko, Anthony B. Response of Wyethia to 2,4-D. April 1951, Northern Rocky Mountain Forest and Range Expt. Sta. Res. Note 98.

2. Mueggler, Walter F. and Blaisdell, James P., (Eastern Idaho). May 1951. Replacing Wyethia with Desirable Forage Species. Jour. Range Management 4(3):143-150.

3. Tingey, D. C. and Cook, Wayne C. May 1955. Eradication of Mule-ear with Herbicides. Utah State Agricultural Experimental Station Bull. 375.

William A. Worf

PLANTAIN LEAF BUTTERCUP (Ranunculus alismaefolius Geyer)

Description and Occurrence

Plantain leaf buttercup and other species of buttercup are widely distributed on mountain meadows and other moist grazing areas in the western states (1). Low palatability and low forage yields are the principal factors that make buttercup undesirable on ranges used by domestic livestock.

Chemicals and Treatment for Control

Two pounds of the alkanolamine salt of 2, 4-D in 9-1/2 gallons of water and 1/2 gallon of diesel oil per acre have given excellent results in controlling plantain leaf buttercup (2). In Oregon, buttercups have been controlled with 1 to 1-1/2 pounds of an amine of 2, 4-D and tolerant legumes such as white clover recovered without necessity of reseeding (3).

Time of Application

Spraying plantain leaf buttercup in late-bloom stage of development gave better kill than earlier spraying (2).

General Considerations

Buttercups are susceptible to the ester forms of 2, 4-D. Although percentage kill was less with the butyl ester form than with the alkanolamine salt, it might be feasible to use the butyl ester form if the spraying of buttercup is being carried out in conjunction with treatment of sagebrush on nearby areas. If buttercup control is the primary objective, then the alkanolamine salt would have the advantage over the butyl ester in being less volatile, less expensive, less likely to injure legumes, and more effective. MCPA has been successfully used in England for buttercup control (4).

References

1. Dayton, W. A. and others. 1937. U. S. Forest Service. Range Plant Handbook. Wide distribution and low palatability of buttercups.

2. Cornelius, Donald R. and Graham, Charles A. September 1953. Berkeley, California. Chemical control of buttercup on mountain meadows. Jour. of Forestry 51(9):631-634. Alkanolamine salt of 2, 4-D gave better control of buttercup at both 1- and 2-pound rates than butyl ester formation. Two-pound rate was superior to 1-pound rate. Diesel oil or emulsion of water and diesel oil was better than aqueous solution. Late bloom stage of growth was preferable to early bloom stage. Native clover (Trifolium longipes) was slight in amount but was not killed by the spraying.

3. Freed, V. H., Furtick, W. R., Laning, E. R., Jr., Warren, Red. February 1954. Chemical weed control recommendations. Ore. Agric. Expt. Sta. Bul. 539.

4. Halliday, D. J. and Templeman, W. G. (England). January 1951. Field experiments in selective weed control by plant-growth regulators. III. Weed control in grassland. The Empire Jour. of Experimental Agric. 19(73):33-45. Buttercups were controlled by a single application of 5 pounds MCPA per acre. Later tests revealed 2 pounds MCPA per acre in late autumn or 2-1/2 pounds MCPA between May and September gave good control.

Donald R. Cornelius

BROOM SNAKEWEED, MATCHWEED, TURPENTINE WEED, YELLOW TOP

(Gutierrezia sarothrae Britt. & Rusby.)

Distribution and Description

Broom snakeweed is a half-shrub with woody roots, crowns, and stem bases. The species name "sarothrae" refers to the dense, broomlike bunches of dry stems. It has an abundance of yellow, showy flowers, and is sometimes confused with green rabbitbrush (Chrysothamnus viscidiflorus). Snakeweed is widely distributed over the Western States, mostly at elevations from 4,000 to 8,000 feet. It is an aggressive plant which invades areas where the climax vegetation has been depleted, and is frequently abundant on the plains and on desert ranges of the Intermountain Region.

Throughout most of its range this plant is considered worthless as forage. However, on the winter ranges in western Utah and eastern Nevada, it ranks as fair forage for sheep during the fall and spring. Heavy utilization of this plant by livestock probably results in sickness or death, but the plant is frequently grazed by domestic animals without ill effects. It has been described as a secondary selenium absorber in Wyoming (1).

Chemical and Mechanical Control

Burning with a flame gun, grubbing, mowing, and spraying with a 15 percent solution of sodium chlorate were successful methods in the Southwest as early as 1939 (3). In more recent work, good control has been obtained with ester, amine, and sodium salt formulations of 2,4-D and esters of 2,4,5-T. In Arizona TCA and DNBP at high rates also gave good kills (4).

Rate of Application, Volume, and Carrier

All of the data cited comes from the Southwest. McIlvain (2) recommends 1 pound of 2,4-D acid equivalent in an ester form applied in either 3 gallons of diesel oil or in an emulsion of 2 to 4 gallons of water and 1 gallon of oil per acre. It appeared that the amine and the sodium salt of 2,4-D were as effective as the ester of 2,4-D, and might be used at the same rate if snakeweed alone was to be killed.

Thompson Chemicals Corporation (5) did not get good kills with 1 pound of the butyl ester of 2,4-D, but 2 pounds in an oil emulsion at a total volume of 5 gallons per acre was very effective.

The esters of 2,4,5-T appeared to be more effective than those of 2,4-D, but its higher cost justified less enthusiastic recommendation.

Time of Application

After full-leaf development, during the period of most rapid twig elongation, and prior to flowering. In areas and years when soil moisture in the growing season is seriously limiting, a more precise definition of timing might be necessary. This timing occurs in May and/or June with possible extension into July in the northern states and provinces.

General Considerations

Attention should be given to improvements in grazing management since invasion is retarded by a good grass cover. Range improvement where snakeweed is already dense appears to be a different, but not entirely separate, problem. The grass release provided by snakeweed control was well demonstrated by Parker (3). He measured a one-year grass-density increase of 196 percent above the increase on untreated plots when all the snakeweed was removed by grubbing.

References

1. Beath, O. A., et al. 1953. Poisonous plants and livestock poisoning. Wyo. Agric. Expt. Sta. Bull. 34.

2. McIlvain, E. H. 1950. Unpublished data on chemical control of turpentine weed-provided by private correspondence.

3. Parker, K. W. 1939. The control of snakeweed in the Southwest. Southwest For. & Range Expt. Sta., Res. Note No. 76.

4. Southwestern Forest & Range Expt. Sta. 1949, 1950, 1951. Annual Reports.

5. Thompson Chemicals Corporation. 1952. Progress Report. Chemical spraying of juniper & pinion pine on Bar-T Ranch, Arizona.

6. U. S. Forest Service. 1937. Range Plant Handbook. U. S. Government Printing Office, Washington, D. C.

Fred H. Tschirley

ORANGE SNEEZEWEED (Helenium hoopesii Gray)

Distribution and Description

Orange sneezeweed is a perennial herbaceous weed of the aster family. Flower heads are sunflower like, up to 3 inches across, solitary or several on long often wooly stalks with orange-yellow ray flowers. Altitudinal range is 5,000 to 12,000 feet and occurrence is from Eastern Oregon to Western Montana and southward to New Mexico and California.

Chemical

Ester of 2,4-D

Rate, Volume and Carrier

Four pounds acid equivalent of 2,4-D per acre has given 85 to 95 percent control. This should be applied in water at a solution rate of 40 to 50 gallons per acre. All parts of the plant should be covered.

Time of Application

Spraying should be done in the pre-bloom stage of plant growth. Flower buds should be forming and plants growing rapidly.

General Considerations

Permanent control cannot be expected unless a good cover of perennial vegetation can be established. Areas on which sneezeweed has been controlled should be rested from grazing at least one year following control or until the residual perennial vegetation has sufficiently improved to prevent reinvasion.

References

1. Doran, Clyde. 1951. Control of Orange Sneezeweed with 2,4-D. Jour. of Range Management 4(1):11-16, January.

2. United States Forest Service. 1937. Range Plant Handbook. U. S. Dept. of Agriculture. Un-numbered publication.

William A. Worf

LEAFY SPURGE (Euphorbia esula L.)

Distribution and Description

Leafy spurge is a noxious field weed of the Euphorbiaceae family. It is a herbaceous perennial that spreads vigorously from rootstocks. The stems are erect with densely leafy branches. Although it is known to have been introduced from Europe, little is known of the extent of its distribution on this continent. It is particularly bothersome in the Northern Rocky Mountain and North Central States and Canada.

Chemicals

Ester of 2, 4-D
Ester of 2, 4-D supplemented with ammate
Polybor
Polybor chlorate
Borascu
Sodium chlorate
Amitrol
Atlacide (3 amino-1, 2, 4-triazole)

Rate, Volume and Carrier

Either 4 or 6 pounds acid equivalent of an ester of 2, 4-D in 20 gallons of water, applied nine times during a four-year period, resulted in 98 percent kill.

Complete kills have been obtained with four pounds acid equivalent of an ester of 2, 4-D and 100 pounds of ammate per acre followed by application of four pounds of 2, 4-D per acre the following spring.

An ester of 2, 4-D at the rate of 3/4 pound acid equivalent per acre together with tillage and seeding of 90 pounds of winter wheat per acre over a four-year period resulted in 99 percent control.

Polybor chlorate at the rate of 15 pounds per square rod gave 100 percent kill by the end of the third year. Polybor at the rate of 30 pounds per square rod gave 99 percent kill by the end of the third year.

Borascu at 30 pounds per square rod resulted in 98 percent kill by the end of the third year and sodium chlorate at six pounds per square rod resulted in 87 percent kill after three years. 2, 4-D ester dust at 15 pounds acid equivalent per acre gave 98 percent kill. Atlacide at 3.5 pounds per 100-square feet resulted in 97 percent kill.

Five pounds per acre of amitrol (3 amino-1, 2, 4-triazole) applied in 1955, followed by three pounds per acre of 2, 4-D in 1956, resulted in 88 percent kill in Montana.

Four pounds of amitrol in 100 gallons of water per acre is recommended for solid stands of leafy spurge.

Time of Application

Amitrol should be applied when leafy spurge begins to bud and flower but before any seed pods form. Treatments of 15 pounds of acid equivalent of 2, 4-D should be made in bud or early bloom stage. Applications of 2, 4-D were made with good results, in central Montana in May, when leafy spurge was in the bud stage.

General Considerations

Intensive cultivation carried on over a two or three year period, or alternated with cropping, will eradicate leafy spurge. Continuance of cultivation must be for a period sufficiently long (at least two years) to kill all roots of all plants. Where cultivating and cropping are alternated, a longer period is required. Regularity of cultivations from early spring to freezeup at 14-day intervals, with perhaps a lengthening of periods as the plants weaken after the first year, are recommended.

References

1. Baker, Lawrence O. 1954. Control of Leafy Spurge (Euphorbia esula) with Herbicides. Res. Prog. Report. Western Weed Control Conference, pp. 6-7.

2. Baker, Lawrence O. 1958. Control of Leafy Spurge with ATA and 2, 4-D. Res. Prog. Report. Western Weed Control Conference, pp. 12-13.

3. Beatty, R. H. 1956. Progress Report on 3-Amino 1, 2, 4-Triazole (Amizol). Proc. California Weed Conference, p. 62.

4. Bohmont, Dale W. 1952. Control of Russian Knapweed, Leafy Spurge, Canada Thistle and Whitetop with Growth-Regulating Compounds. Res. Prog. Report. Western Weed Control Conference, p. 13.

5. Krall, James L. 1955. Chemicals and Competitive Crops for the Control of Leafy Spurge in Central Montana. Montana Agr. Exp. Sta. Bull. 510, pp. 1-15.

6. Kratochvil, D. E., Stahler, L. M., and Derscheid, L. A. 1951. Chemical Control of Weeds in South Dakota. South Dakota Agr. Exp. Sta. Bull. 69, p. 6.

7. Davis, Ray J. 1952. Flora of Idaho, p. 460.

William A. Worf

ST. JOHN'S WORT, GOATWEED, OR KLAMATH WEED

(Hypericum perforatum L.)

Description and Occurrence

St. John's Wort is one of the most aggressive, noxious, introduced range plant invaders. By 1951, it had invaded more than 2 million acres in the western United States. Infestations probably extend over twice that many acres now. Its most objectionable feature is its ability to crowd out valuable range forage once it obtains a foot-hold through disturbance or misuse of range.

St. John's Wort is a perennial plant. It grows in rather dense patches and spreads both by seeds and root stocks. The plants grow to a height of 15 to 25 inches and have yellow, five-petaled flowers. The flowers are about three-fourths of an inch in diameter. The petals have numerous black dots around the edges, the more or less oblong shaped leaves are arranged in pairs along the stem and have small pin-hole-like glands that appear to be transparent when held up to the light.

This plant is a native of Western Europe and has spread practically around the world.

Chemicals

The three chemicals which are most commonly used for control are commercial borax, proprietary forms of borax (Borascu), and 2,4-D. Borax preparations are used on small out-lying infestations, while the 2,4-D is used on the larger infestations and scattered stands.

Rate, Volume and Carrier

From 4 to 8 pounds of borax per square rod, have been used, but the heavier application is the most satisfactory. This treatment is usually applied in the spring. The chemical is broadcast on the soil or drilled in.

Treated stands should be marked and follow-up checks made to insure that all plants are killed.

2,4-D is applied at the rate of 2 to 3 pounds or more of acid equivalent per acre applied in early summer, or when the plants are in the bud stage. Either water or oil is used as a carrier and applied at a minimum rate of 10 gallons of water or 3 gallons of oil per acre.

The cost of chemical treatments limits their use. However, they can be justified as a means of preventing the spread from sporadic infestations.

General Considerations

Range in good or excellent condition is less likely to be invaded by St. John's Wort.

Biological control of St. John's Wort by insects has been attempted through the introduction of beetles which feed specifically on St. John's Wort plants. Beetles have given highly successful control on extensive stands in California and later in other states where they were subsequently introduced.

Root borers are currently being tried in some sites in the West but provide less successful control than the beetles.

Proper grazing following the decline of St. John's Wort from chemical or biological control measures will help prevent the increase of other undesirable weeds in the same area.

References

1. Baker, L. O., et al. 1956. Weed control in Montana on lawns and in crops on range. Montana State College Agri. Expt. Sta. C-210.

2. Evanko, Anthony B. 1953. The test of borax control of goatweed. Northern Rocky Mt. Forest & Range Expt. Sta., USFS Mimeo. 134.

3. Harris, Grant A. 1951. St. John's Wort on western ranges. Northern Rocky Mt. Forest & Range Expt. Sta., USFS Sta. Paper No. 26.

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Karl G. Parker

TANSY RAGWORT (Senecio jacobaea L.)

Distribution and Description

Tansy ragwort was introduced to America from Europe. It was first reported from the northeastern United States and the province of Quebec, but has since been reported from the Island of Vancouver and from British Columbia to northern California. There is no published record of its occurrence in the North Central States, indicating that this may have been a double introduction, one taking place in the East and the other in the West. Leaves are 2 to 8 inches long and finely divided. The yellow flower heads are one-half to three-fourths of an inch wide.

Chemicals

Tansy ragwort can be controlled if it is treated in the proper stage. Hughes (4) reports an 80 percent kill using the amine of 2, 4-D. Furtick and Chilcote (2) report that the butoxyethanol ester of 2, 4-D was the most effective chemical tested. Amitrol was not effective at any stage of growth.

Rate of Application, Volume and Carrier

Furtick and Chilcote (2) reported a rate of 2 pounds 2, 4-D acid equivalent per 100 gallons of carrier was adequate for effective control. Hughes had good success with 1.5 pounds acid equivalent of the amine in 40 gallons of water per acre. Little work has been done with carriers for the control of this species.

Time of Application

Control was effective only when treatments were made at the rosette or bolt stages. Later treatments were not effective with any chemical.

General Considerations

This species is apparently spreading quite rapidly and is becoming a cause for concern, especially in the Pacific Northwest. It invades pastures, wet places, and cultivated ground, particularly. In addition to its competitive characteristics it is also poisonous. This weed has a potentially greater geographic distribution and we will no doubt be hearing much more about it in future years.

References

1. Anonymous. 1955. Control of weeds on ranges and pastures. Proc. 8th Ann. Can. Weed Control Conf.

2. Furtick, W. R., and D. O. Chilcote. 1955. A comparison of various herbicides on tansy ragwort when applied at rosette, bolt, and bloom stages. Res. Prog. Rpt. WWCC.

3. _____. 1955. The use of amino triazole on tansy ragwort in the rosette, bolt, and bloom stages. Res. Prog. Rpt. WWCC.

4. Hughes, E. C. 1955. Effect of herbicides on ragwort (Senecio jacobaea) Res. Rpt., Nat. Weed Comm., Western Sec. (Can.).

5. Renney, A. J. 1955. Tansy ragwort (Senecio jacobaea L.) in British Columbia. Res. Rept., Nat. Weed Comm., Western Sec. (Can.).

6. List of weeds in the 11 western states, compiled by A. N. Stewart, Curator, Oregon State College.

Fred Tshirley and W. C. Robocker

CLUSTER TARWEED (Madia glomerata Hook.)

Distribution and Description

Cluster tarweed is a herbaceous annual of the Compositae family that attains a height of 4 to 20 inches. In the Intermountain area it most commonly occurs in openings at elevations from 6 to 10 thousand feet. It is a heavy invader of overgrazed mountain ranges that frequently have high potential. Tarweed seed germinates early in the spring (occasionally under snowbanks) and makes vigorous growth, maturing in late summer. It is distributed from Saskatchewan to Colorado and California and introduced eastward.

Chemicals

Esters, amines or sodium salts of 2,4-D

Rate, Volume and Carrier

Amines or esters of 2,4-D, should be applied at the rate of 1/2 to 1 pound acid in 30 gallons of water per acre. It is important to wet the plant thoroughly.

If the sodium salt of 2,4-D is used, it should be applied at the rate of 1 pound in 30 gallons of water per acre.

Time of Application

Spraying should be done before the tarweed plants reach the four-leaf stage of growth. Reduced kills resulted when plants were sprayed in the 6- to 10-leaf stage of growth.

General Considerations

Soil cultivation after foliage leaves develop, but before seed begins to form, will also kill tarweed.

Adapted grasses should be planted before or immediately following tarweed kills to prevent reinvasion.

References

1. Davis, Ray J. 1952. Flora of Idaho, pp. 768-769.
2. Parker, Robert E. 1950. The Inhibitory Effects of Madia glomerata Upon Seed Germination and Plant Growth, Thesis, Univ. of Utah, p. 55.
3. Plummer, Perry A., Hull, A. C., Jr., Stewart, George, and Robertson, Joseph H. 1955. Seeding Rangelands in Utah, Nevada, Southern Idaho and Western Wyoming, U.S. Dept. of Agri. Handbook No. 71, pp. 24-25.
4. Stevenson, E. W. 1950. Reseeding Tarweed Infested Ranges. U. S. Forest Service, Pacific Northwest Expt. Sta. Research Note 68, p. 6.
5. U. S. Forest Service Intermountain Forest and Range Expt. Sta. Annual Report. 1952. Artificial Revegetation, pp. 27-29.

William A. Worf

CANADA THISTLE (Cirsium arvense Scop.)

Description and Occurrence

Canada thistle was introduced into the United States and Canada during the time of the Revolutionary War. This perennial weed is widespread throughout the northern United States extending south to California and Virginia. Although considered of primary importance on cereal grain land, it now occurs on many types of farming and grazing land and spreads into forest areas. Reproduction is by creeping rootstocks and seed. Stems are 1 to 4 feet high, erect, rigid, and slightly pubescent. Plants are dioecious, that is, two types of flowers are produced: female (pistillate) and male (staminate). Usually the flowers on one plant are all of one type.

Chemicals for Control

Although somewhat resistant to 2,4-D, canada thistle has been successfully controlled by repeated treatment with this selective herbicide. Amitrol has given good results. More recent tests with trichlorobenzoic acid have shown it to be more effective than 2,4-D or amitrol (6).

Rate, Volume, and Carrier

Two pounds, acid equivalent per acre, of the amine of 2,4-D is recommended per treatment. Over 90 percent of the original stand has been eliminated after 3 years' treatment (2). Water sufficient to give thorough coverage has been recommended as a carrier (4).

Heavy rates of 2,4-D, from 40 to 80 pounds per acre, applied in early spring have given complete control of established stands of Canada thistle (3).

The rate recommended for amitrol is 4 pounds in 20 or more gallons of water per acre. Amitrol is more effective but also more costly than 2,4-D. It is more practical for eradicating patches of Canada thistle (7).

Time of Application

First spray application is usually applied at pre-bud or early bud stage of development in late May or early June. Follow-up fall treatment should be 1 or 2 weeks before first frost but treatment can be applied later, even after several light frosts (4). Clean cultivation from May through July, with 2,4-D applied at rate of 2 pounds per acre about September 15, has given excellent results (5). After a period of clean tillage, this fall spraying hits the plants while the leaves are young and succulent and carbohydrate translocation is at a relatively high level.

Amitrol should be applied between the time most thistles have emerged and the bud-to-bloom stage. Treated plants should not be mowed, but they may be plowed under 3 weeks after spraying (1).

General Considerations

Canada thistle should be controlled by spot treatment when in early stage of invasion if possible. Considerable amounts of chemicals and time will be required in treating and retreating if this perennial is allowed to spread over an extensive acreage. Abandoned crop land is most likely to be infested.

Experimental work in Montana showed more effective control with 2,4-D when used with competitive crops such as wheat or pasture grasses than when used without cropping (8). Plots of seeded pasture that were sprayed with 2,4-D and mowed 2 or 3 times gave almost complete eradication of Canada thistle. Only 0.1 percent of the original stand was left after 3 years.

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Donald R. Cornelius

WATER-HEMLOCK (Cicuta spp.)

Description and Occurrence

Water-hemlock is a native perennial which reproduce both by seeds and fleshy roots. It grows in marshy ground and along streams where there is an accumulation of rich loamy soils.

It occurs abundantly in northern and eastern United States and in adjacent Canada, extending southwestward.

The stems are erect, branching, stout, hollow and jointed. Leaflets are distinguished by the peculiar manner in which the veins in the leaflets run to the notches on the edge of the leaflet. It has a characteristic appearance of the parsley family.

Chemicals

The ester form of 2,4-D is the most practical chemical for use in controlling water-hemlock. Soil sterilants often are impractical because of the excessive moisture of the sites in which this plant normally grows.

Rate of Application, Volume and Carrier

2,4-D applied in the early growth stage and up to the early bud stage has produced excellent kills. It is considered to be very sensitive to 2,4-D in these stages. Water is used as the carrier and applied at approximately 10 gallons per acre, or more, where the infestation is very dense and growth is luxuriant, 2,4-D should be applied at the rate of 2 pounds per acre.

General Considerations

Where it is a problem, water-hemlock is one of the more deadly poisonous plants.

Caution should be taken to remove livestock from sprayed areas. 2,4-D sprays tend to increase the palatability of water-hemlock to livestock. Plants normally ignored by cattle grazing in the pasture are more readily grazed following spraying and may cause serious losses.

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Karl G. Parker

WHITETOP (Cardaria draba, Desv.)

Distribution and Description

Whitetop is a noxious weed of cultivated ground and roadsides and is spreading over many rangelands. It has ability to spread underground, as well as by seeds. It was introduced from Europe and is now widespread in North America.

Chemicals

Amitrol
2,4-D amines
2,4-D esters
Sodium chlorate
Carbon bisulfide

Rate, Volume and Carrier

Amitrol at the rate of 10 pounds per acre, and 2,4-D amine at the rate of 20 pounds acid equivalent per acre gave complete control in Wyoming. Both were applied in water at a solution rate of 40 gallons per acre.

Four pounds acid equivalent per acre of either an ester or amine of 2,4-D plus a wetting agent in 40 gallons of water gave 90 percent kill in Wyoming.

2,4-D ester applied at the rate of 1 pound acid equivalent per acre three times each season for two successive years has given 95 percent control. It was applied in sufficient water to thoroughly wet the plant.

The addition of a wetting agent appears to greatly increase the effectiveness of 2,4-D.

On non-saline soils, fair results have been obtained by applying six pounds of sodium chlorate per square rod.

Time of Application

Applications of 2,4-D are most effective at the bud stage of growth and the late fall rosette stage of growth.

General Considerations

2,4-D when used alone, is less effective in controlling whitetop than when it is combined with cropping and cultural practices.

Soil sterilization to eradicate whitetop has been unsuccessful in many cases because it is quite tolerant to sodium chlorate, particularly on alkaline soils.

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William A. Worf

WILD IRIS (Iris missouriensis Nutt.)

Description and Distribution

Wild iris, Rocky Mountain iris, or western blue flag, is a native iris which grows in wet meadows and along streams from North Dakota to New Mexico and westward to the Pacific Coast from Southern California to British Columbia (5). It is a perennial herb and appears to spread chiefly by rootstocks. Seed is abundantly produced, although data on germination are not available. Its pale blue to almost white flowers are borne on stalks 6 inches to 40 inches in height and are conspicuously visible in overgrazed pastures and ranges where soil moisture is high. It is worthless as a forage plant and constitutes a source of competition for moisture and nutrients with more desirable species.

Chemicals

Both the light and heavy esters of 2,4-D (1, 2, 3, 4) have been found to be satisfactory for wild iris control, although Thornton found the heavy ester caused some injury to grass.

Rate of Application, Volume and Carrier

Two to 4 lbs., a.e., of an ester of 2,4-D per acre in either oil or water or in an oil-water emulsion, at a volume of carrier adequate to secure satisfactory coverage is recommended. Volumes of 3 to 100 gpa have been used with success.

Time of Application

Herbicide may be applied during the bud stage of development (3) or at early flowering (1) of wild iris. Cords (2) obtained best control in Nevada using 4 lb/A of 2,4-D applied just after blooming.

General Considerations

In spite of the scarcity of published data on wild iris control, the effectiveness of the controls recommended above were quite definite. Thornton (4) and Cords (2) tried other chemicals as well as 2,4-D, and although they found dalapon (2, 2-dichloropropionic acid) to be effective, it was as harmful to grass as to wild iris. Thornton also found 2,4,5-T and a mixture of 2,4-D and 2,4,5-T were less effective than 2,4-D alone and also caused injury to grass.

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W. C. Robocker

CHAMISE (Adenostoma fasciculatum H. &A.)

Description and Occurrence

This evergreen shrub grows on mountain slopes and ridges at elevations of 500 to 5,000 feet occurring throughout the foothills of the Sierra Nevadas and Coast Range in California (1). The plant is upright and coarse, 2 to 10 feet in height or taller. Chamise is an excellent example of a fire type with strong reproductive power in sprouting from numerous dormant buds at base of stems and in germination of seed following fire to give dense stands of seedlings. Mature chamise is one of the most unpalatable shrubs in California for domestic livestock. New sprouts are eaten as browse by sheep and deer.

Chemicals for Control

No chemical spray has been found satisfactory for killing mature plants. The practical procedure is to remove old growth by burning or by mechanical means and to spray the sprouts and seedlings with 2,4-D (1). The propylene glycol butyl ether ester and the butoxy ethanol ester were more effective by far than the isopropyl ester, the amines, or acid formulations of 2,4-D on chamise. Some recent work with fenuron and monuron pellets indicates that these chemicals may be applied to the soil to kill chamise plants (3).

Rate, Volume, and Carrier

Three pounds of acid equivalent of the low volatile ester of 2,4-D in 10 gallons of diesel oil - water emulsion per acre is the recommended treatment for application by airplane or by ground equipment on sprouts and seedlings following a burn (2). The diesel oil to water ratio should be 1 to 8. Some follow-up treatment by ground sprayer may be needed especially where some other sprouting species such as live oak, leather oak, scrub oak or coffee berry is mixed with the chamise. The spray mixture suggested for this retreatment is 1 gallon of brush killer (4 pound mixture of 2,4-D and 2,4,5-T esters) in 1 gallon diesel oil and enough water to make 100 gallons of spray (2). This solution should be applied to wet the sprouts thoroughly.

Monuron and fenuron pellets broadcast in November before the winter rains had started at the rate of 32 pounds per acre (8 pounds of active ingredient) gave complete kill of chamise, and application at the rate of 16 pounds per acre (4 pounds of active ingredeent) killed most of the plants (3). More research is needed to determine minimum dosage, best time of application, and results over variable soil and climatic conditions.

Time of Application

Chamise plants are most readily killed with 2,4-D by spraying the young sprouts in the spring following a fall burn. Spraying too soon before all of the potential sprouting portions of the burl had developed sprouts resulted in many plants not being killed (1). Delaying the spraying until after the soil moisture was greatly reduced also resulted in a poor kill. Thorough coverage of the sprouts is needed to insure good kill. Adequate coverage seems difficult after the sprouts are 6 inches or more in length. This timing with sprout development usually permits most seedlings to have emerged and to be sprayed at a susceptible stage along with the sprouts. However, delayed germination may occur as much as a year after the burn; so follow-up treatment with broadcast spraying is required. If only spot treatment is required for sprouts, then follow-up treatment may be done by use of hand sprayer.

General Considerations

Highly successful conversion of chamise brushland to grass has been reported by the California Forest and Range Exp. Sta. (5). The mature brush was burned and seeded to range grasses and then sprayed with 2, 4-D to control sprouts and seedlings of chamise.

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Donald R. Cornelius

CHOLLA CACTI (Opuntia spp.)

Distribution and Description

The major distribution of cholla cacti is centered in desert and semi-desert areas, with Arizona having the highest population in North America. Arizona and New Mexico are the primary states where cholla cacti is a problem on rangelands. Cholla cacti belong to the genus Opuntia. They are characterized by having cylindrical joints, inconspicuous glochids, and sheathed spines. In growth form they vary from low-growing, spreading plants to tall, arborescent forms.

Best Herbicides

There are no herbicides presently available that will control cholla cacti economically on extensive areas. Currently, the only place for chemical control of cholla lies in spot treatments of small localized infestations. In this respect, a number of herbicides can be used to advantage. Tschirley (5) has data showing that the low volatile ester of silvex and 2, 4, 5-T will give adequate control. Roach and Glendening (3, 4) report further that TCA and DNBP are effective for spot treatments.

Rate, Volume, and Carrier

High concentrations must be used. Eight to ten lbs. ahg are recommended for silvex and 2, 4, 5-T, while 12 lbs. active ingredient per 100 gallons is recommended for DNBP. One-half to three-fourths pound of TCA per gallon of water also gives adequate control. With the exception of TCA, diesel oil was the best carrier for the other herbicides mentioned. In all cases, a high volume was necessary. Plants were individually sprayed to the point of drip. Tschirley (5) also reports that 4 pounds acid equivalent per acre in a total volume of 40 gallons of diesel oil: water emulsion gave only a 12 percent kill. It is apparent, therefore, that both high concentrations and high volumes are necessary to achieve effective control of cholla cacti.

Time of Application

July and August are the best months for treatments with silvex and 2, 4, 5-T. DNBP and TCA can be effectively used over a wider range of season, but treatments should not be made during extremely dry seasons (3).

General Considerations

It is doubtful that chemical control alone will ever be a practical method of controlling cholla. Even if a complete kill were obtained, there would be a large number of dead joints lying on the ground which would prevent proper utilization of forage species by livestock. This is especially true of jumping cholla (O. fulgida Engelm.). Since approximately 40 percent of a cholla infestation can be killed (2) by the use of fire, it seems that fire may become a valuable tool for the control of cholla.

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Fred H. Tschirley

GALLBERRY (Ilex glabra [L.] Gray)

Description and Occurrence

Gallberry, a member of the holly family, is a common evergreen shrub, usually 2-5 feet tall that occurs abundantly in low pinelands, swamps, and prairies of the Southeastern Coastal Plain region. It spreads both by seed and rhizomes. This plant is worthless for browsing, acts as a physical barrier to good forest land management, increases the hazard and intensity of forest fires, and competes unfavorably with desirable forage plants and tree reproduction.

Chemicals for Control

Halls and Burton (1) report kills of 90 percent from spray applications of 2, 4, 5-T (isopropyl ester) singly and in a combination with 2, 4-D (isopropyl ester). The latter was not effective by itself. Fair results (50% kill) were obtained with sodium trichloroacetate (TCA). Hughes (2) reports the number of gallberry stems was reduced 75 to 80 percent by spray applications of isopropyl ester of 2, 4, 5-T.

Rate, Volume, and Carrier

Most effective treatments in first trials (1) were 1 gallon of undiluted formulation (3.34 pounds acid equivalent of isopropyl ester of 2, 4, 5-T) per 100 gallons of water or a combination of 2.5 pounds 2, 4, 5-T and 2.5 pounds acid equivalent of 2, 4-D per 100 gallons of water, at rate of 175 gallons per acre. Later tests (2) indicate that per acre rates of 2 to 3 pounds acid equivalent of 2, 4, 5-T in 100 gallons of water may be just as effective as higher concentrations.

Preliminary trials indicate that an oil carrier is preferred for fall and winter sprays, but water is more effective during spring and summer.

TCA has been tested at one rate only, 12 pounds per 20 gallons of water, 175 gallons per acre.

Time of Application

Good results have been obtained from spring and summer applications with water as carrier and from fall and winter applications with oil as carrier.

General Considerations

Longtime residents of south Georgia and north Florida frequently comment on the apparent increase of this plant. With greater emphasis on timber and grazing land management practical methods of gallberry eradication and control take on added importance.

Periodic burning of critical areas is the control method generally employed by landowners. This has a temporary effect of eliminating top growth. Resprouting following the burn is profuse and stems may actually become more numerous. Burning of gallberry six weeks to two months prior to spraying does not increase effectiveness of chemical.

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Lowell K. Halls

GREASEWOOD (Sarcobatus vermiculatus Torr.)

Description and Occurrence

This is a spiny shrub which is common on alkali soils in many western states. It is a valuable fall and winter browse for livestock, provided it is eaten with other forage in ordinary amounts. The oxalate in young stems and fresh leaves has caused poisoning in sheep. Often there are but few other forage species in association with greasewood which might increase and offer incentive for greasewood control. The value to be gained on other areas is apparently an empirical estimate regarding the response of giant wild rye, salt grass, or other forage species. It seems advisable to proceed with greasewood control only when its value has been considered.

Chemicals for Control

No data is available for citation, although considerable confidence has been expressed in the use of 2,4-D. Bohmont offered a positive recommendation, and Stoddart observed that greasewood is very highly susceptible to crown kills.

Rate, Volume, and Carrier

Bohmont advised that 2,4-D esters or amine at 1 to 2 lb/A has given 100 percent kill of greasewood. Volume and carrier is not stated, but it may be presumed that with this high susceptibility any carrier might be used at volumes as low as 5 gal/A.

Time of Application

Spray when greasewood is growing rapidly.

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D. N. Hyder

JUNIPERS (Juniperus spp.)

Description and Occurrence

In the western states junipers are shrubby, coniferous trees characteristics of the pinyon-juniper woodlands which occur at intermediate elevations above the desert, grassland, or chaparral types and below the ponderosa pine type. In the eastern half of the United States eastern redcedar (Juniperus viginiana L) grows as a medium-sized tree. Various species of juniper may be found growing in most of the western states, but invasion of grazing lands and the resultant loss of forage is probably most serious in Arizona, New Mexico and Texas. The more important problem species of the western states are: alligator juniper (J. deppeana Steud.), Ashe juniper (J. ashei Buchholz), one-seed juniper (J. monosperma (Engelm.) Sarg.), Pinchot juniper (J. pinchotii Sudw.), and Utah juniper (J. osteosperma (Torr.) Little); of these one-seed and Utah junipers are the most widespread and are probably the most important problem species. Alligator and Pinchot junipers are sprouting species.

Chemicals for Control

At present there is no chemical which can be recommended for widespread use in a chemical control program for junipers. Variable results with different chemicals and different species complicate the picture. Intensive work is now underway on the western species, especially Utah, one-seed, and alligator juniper. Some encouraging indications are being obtained from this work.

Foliage applications of 2,4-D or 2,4,5-T and combinations of the two have given good kills, but high concentrations and high volumes were necessary (1, 3, 8). Polychlorobenzoic acid is effective on common juniper and eastern redcedar (7) and encouraging indications have been obtained with several chloro-substituted benzoic acids on alligator, one-seed, and Utah junipers (4). Ammate has been the most effective chemical used on one-seed juniper (2) and it killed all top growth on Ashe and Pinchot juniper (10).

Basal treatments using DNC in diesel oil gave kills of 50-100 percent, but the method is slow and laborious (1). Sodium arsenite is effective in a basin or frill treatment (6), but it is not widely used because of its poisonous nature.

Rate, Volume and Carrier

Rates of 8 to 10 pounds ahg and high volumes with complete coverage of the tree have been necessary to achieve effective control in foliage treatments. Aerial application of 2,4-D and 2,4,5-T alone or together onto Utah juniper at rates up to three pounds per acre in oil-water emulsions resulted in heavy initial damage (9) but did not kill the trees. An oil carrier for 2,4-D applications onto junipers has been recommended (5) but a 1:3 oil-water emulsion appeared to be as good (1).

In basal treatments DNC at 15 pounds per 100 gallons of diesel oil or 2,4-D at 4 pounds ahg of diesel oil is effective (1).

Time of Application

Early spring or late fall appear to be the most favorable seasons for foliage applications onto Utah juniper (1). Spray applications when the juniper is actively growing or when the soil moisture is medium or high has been recommended (5).

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T. N. Johnsen, Jr.

Manzanita (Arctostaphylos spp.)

Description and Distribution

Arctostaphylos species are evergreen shrubs with thick and usually entire leaves. Bark is dark red or chocolate-color. Flowers are white or pink with an urn-shaped corolla. The manzanitas are distributed throughout the western United States (6). They are typically found on dry sites growing in full sunlight. They are especially abundant in the chaparral belts of Arizona, California, and the Oregon foothills.

Chemicals for Control

There is almost uniform agreement among research workers that esters of 2,4-D are more effective than, or equally as effective as esters of 2,4,5-T. Turner (7) found in Arizona that 2,4,5-T gave slightly better results, but work in California and Oregon (1, 2, 4, 5) shows that 2,4-D is most effective.

Rate, Volume, and Carrier

Rates of 1 to 2 lb/A in low volume applications and 4-6 lb ahg in high volume applications are recommended (2, 4, 5). Water is generally recommended as a carrier for non-sprouting species, while an emulsion of diesel oil in water is used for sprouters. Dahms (2) recommends 150 gpa in Oregon; Turner (7) obtained 80-90 percent control with 10 gpa in Arizona.

Time of Application

As is the case with other brush species, manzanitas can be most effectively controlled if treated during the period of active growth.

General Considerations

Manzanita is relatively easy to control with chemicals, but some difficulty is experienced with sprouting species. A patula Greene and A. glandulosa Eastw. are common sprouting species. A. manzanita Parry, A. glauca Lindl., and A. pungens H.B.K. are common non-sprouting species. A word of caution is necessary, however, where manzanita is being sprayed to release ponderosa pine reproduction. Ponderosa pine can tolerate about twice as much 2,4,5-T as 2,4-D and can tolerate about twice as much of either chemical in a water carrier as in an emulsion (1). Both manzanita and pine are most susceptible in late June or early July; less susceptible earlier or later.

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Fred. H. Tschirley

MESQUITE (Prosopis juliflora (Sw.) DC.)

Description and Distribution

Three varieties of mesquite occur in the United States (1). Velvet mesquite (var. velutina (Woot.) Sarg.) is found principally in Arizona; honey mesquite (var. glandulosa (Torr.) Cockerell) is found in Texas and New Mexico; and western honey mesquite (var. torreyana L. Benson) is found principally in southwestern New Mexico, southeastern and western Arizona, and California. Velvet and honey mesquite are of most importance and the following discussion is limited to them.

Velvet mesquite is a tree up to 45 feet tall. Primary leaflets are in one or two pairs, secondary leaflets in 14-30 pairs, each leaflet oblong, 7-13 mm long and 2-4 mm wide. Honey mesquite is a shrub or small tree 9 to 25 or 30 feet tall. Primary leaflets are in one or rarely two pairs, secondary leaflets in 6-13 pairs, each leaflet linear or narrowly linear-lanceolate, 24-63 mm long and 2-4 or rarely 6 mm wide.

Chemicals for Control

The low-volatile esters of 2, 4, 5-T are most effective for foliage applications on both honey and velvet mesquite. Low-volatile esters of silvex can be substituted for 2, 4, 5-T on honey mesquite (4), but not on velvet mesquite. Soil treatments using monuron or fenuron in water have been effective when applied near the truck base. Pelleted monuron or fenuron applied around the base have also been successful. Basal stem treatments using diesel oil or diesel oil fortified with esters of 2, 4, 5-T are successful on single or several-stemmed trees, but the method is too laborious for multiple-stemmed trees.

Rate, Volume, and Carrier

The recommendation for aerial spraying on honey mesquite in Texas is 1/2 lb/A acid equivalent of a low-volatile ester of 2, 4, 5-T in a carrier consisting of 1/2 gal. of diesel oil and 2-1/2 gal. of water. Applications are made in a 60 ft. swath width (4).

Three-fourths of a lb of a low volatile ester of 2, 4, 5-T in 2 gallons of diesel oil and 8 gallons of water per/A has been recommended for aerial applications on velvet mesquite (5). However, recent work (7) indicates that 1/2 lb/A acid equivalent of an ester of 2, 4, 5-T in a 1:7 diesel oil: water emulsion and a 5 gpa volume applied in two successive years is much more effective.

Monuron and fenuron are effective for individual-tree treatments at a rate of 1/8 to 1/4 lb active ingredient per gallon of water applied to the soil around the bases of trees. Monuron and fenuron can also be used as pellets at a rate of three to six grams per tree.

Diesel oil applied to stems about 8 inches above ground line is the most economical method for controlling scattered stands of velvet mesquite (5). Sufficient oil (about one pint) should be used so that it runs down the stem and comes in contact with the dormant buds at the root-crown transition zone. The cost of this method is about $0.05 per tree. Eight lbs. of an ester of 2, 4, 5-T per 100 gal. of diesel oil is recommended for basal treatments on honey mesquite, but the method of application is the same.

Time of Application

Foliage treatments to honey mesquite should be made 40 to 90 days after first leaf emergency (4) and when conditions for growth are favorable. The critical period for

velvet mesquite is at the time the leaves have reached full size, but are still succulent and flower development is complete. This period usually occurs in May, 40 to 60 days after first leaf emergence.

Soil treatments with monuron or fenuron should be made shortly before a rainy season so that the material is carried into the soil where it can be absorbed by the roots. These herbicides are believed to be inactivated by light so prolonged exposure on the soil surface would reduce their effectiveness.

Basal treatments with diesel oil or fortified diesel oil can be made at any time of the year.

General Considerations

Aerial applications to honey mesquite result in complete topkill. Plants sprout from the base, but the sprouts grow slowly. Retreatment is necessary at intervals of five to seven years (4). Aerial applications to velvet mesquite result only in defoliation and a retreatment must usually be made in the following year (7).

Research in Arizona has shown that about 50 percent of the perennial grass forage is lost when there are 25 mature mesquite trees per acre (6). Consequently, the greatest return per dollar invested is obtained by individual plant treatments in areas where there is just a scattered stand.

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Fred H. Tschirley

BLUE OAK (Quercus douglasii H. &A.)

Description and Occurrence

Blue oak occurs over several million acres of woodland-grass rangeland in California. The trees are 20 to 60 feet high and thrive on dry or rocky foothills of the Sierra Nevadas and inner Coast Range mountains. An excessive number of trees on a range unit reduces production and utilization of forage. Forage produced beneath the trees is less palatable to livestock than forage produced on similar areas without trees. Cattle consuming large quantities of acorns may suffer impairment of health. Blue oak density or combination with brush and other trees may cover so much of the range that handling the livestock is difficult and the grazable acreage is too low. A few scattered blue oaks may be advisable for shade in summer and for promoting growth of early winter forage by protecting annual understory plants. Basal sprouts usually appear when trees are cut.

Chemicals for Control

Foliage sprays have not given as satisfactory results as cut-surface treatment of the trunks of the tree. Amines of 2, 4-D and 2, 4, 5-T were both effective and about equal when applied to cuts in the trunk. The ester of 2, 4, 5-T was appreciably more effective than 2, 4-D (1). The amine of 2, 4-D should be used, as it is cheaper and produces as good a kill as the other chemicals (1).

Rate, Volume, and Carrier

The amine of 2, 4-D can best be applied undiluted, 4 pounds of acid equivalent per gallon. Cuts should be made horizontally by a hatchet or ax and spaced every 4 inches around the trees. Cuts should penetrate through the bark and into the sapwood. The chemical must be applied to the sapwood if good kills are to result (1). Cuts made near the ground are more effective than those made higher on the trunk.

The amine of 2, 4-D is applied by means of a pump oil can. Experiments with rate of application showed that 4 milliliters per cut was the optimum amount for best kill of Blue oak. One gallon of chemical should be adequate to treat 300 trees 1 foot in diameter (1).

Hand equipment that combines the operation for making the cut and applying the chemical has now become commercially available. A hollow-pointed probe is jammed through the bark into the sapwood. A valve release mechanism can then be turned to let the desired amount of chemical flow through the hollow tube and out through the tip into the cut.

Time of Application

Blue oak is most susceptible to kill by the cut-surface method in winter and spring. Sensitivity increases markedly between August 8 and November 4 (1). Trees reach a high point in sensitivity in November when there is a complete absence of growth in the tops of the trees, approximately 1.5 inches of rain falls and air temperatures become lower, thus decreasing transpiration. Roots probably start growing about this time. Top kill occurs more rapidly when trees are treated just prior to appearance of new leaves in the spring. Fall applications show no visible effect until the following spring when growth starts (1).

General Considerations

A control burn will usually be needed from 3 to 5 years after chemical treatment of Blue oak to clear out the dead and fallen debris. An increase in palatability of forage under treated trees has been observed the first season after treatment.

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Donald R. Cornelius

POST OAK (Quercus stellata Wangenh.) and BLACKJACK OAK (Quercus marilandica Muenchh.)

Description and Occurrence

These two oaks are commonly associated with each other. Post oak is distributed from Cape Cod west through Central Ohio, south to Iowa, south to Central Texas and Northern Florida. Blackjack oak is quite widely distributed and occurs rather abundantly in certain areas of the following states: New York, New Jersey, Pennsylvania, Ohio, Michigan, Illinois, Missouri, Iowa, Kansas, Oklahoma, Texas and Florida.

The above two oaks have little to no grazing or commercial value. They form dense stands on areas that have been heavily grazed or where desirable hardwoods have been removed. This is especially true in Texas where these undesirable woody species have increased in numbers on approximately 18 million acres of range lands. These oaks have a relatively high water requirement and compete effectively with forage species for soil moisture.

Methods of Control

Mechanical--Such methods as bulldozers, anchor chains and girdling on large trees have given various degrees of success. Brush and weed cutters as well as root plows have been quite useful in the control of oak saplings. However, under such treatments some provision should be made for the grazing of goats to control the sprouts which arise following such treatments.

Chemical--These oaks can be controlled with one or two aerial applications of 2, 4, 5-T or silvex (2, 4, 5-trichloropropionic acid) esters. Recommended treatments are 1-1/2 to 2 pounds of 2, 4, 5-T or 1-1/4 to 2 pounds silvex per acre (acid equivalent basis) initially followed by an additional 1 to 1-1/2 pound of 2, 4, 5-T or 3/4 to 1 pound of silvex during the first or second subsequent growing season. Aerial applications are made as 1:3 oil/water emulsions at a volume of four gallons per acre. Black oak is less susceptible than post oak to these chemicals, and 2, 4, 5-T should be used when both oak or other weed tree species are present.

Post and blackjack oak can also be controlled using individual plant treatments by spraying the foliage, the stem from ground level up 12 to 14 inches or by injecting the killing solution into the plant directly or into the soil at the base of the tree. Foliage sprays containing 2 to 3 ahg (acid equivalent per 100 gallons) of 2, 4, 5-T or silvex should be applied to the point of runoff. Spraying the trunk base with a solution of 12 to 16 pounds ahg of 2, 4, 5-T in diesel oil is effective on trees with stems not greater than five or six inches in diameter. Silvex should not be sprayed on the trunk base.

Various herbicides such as 2, 4, 5-T, silvex and ammate (ammonium sulfamate) may be injected directly into the plant by utilizing freshly-cut surfaces such as frills or stumps near the ground. Frills consist of a band of overlapping downward ax cuts completely circling the trunk. Better kills are obtained from frills and stumps cut near the ground level. Particular attention should be paid to treating the cambium and outer bark surface of stumps. Oil solutions containing 12 to 16 ahg of 2, 4, 5-T or silvex are effective; Ammate can be applied as crystals or in water solutions containing not less than three pounds of ammate per gallon.

Injection of oil solutions containing 8 ahg of 2, 4, 5-T into the soil at the base of trees less than six to eight inches in diameter is an effective treatment. An inexpensive soil fumigating gun is used for making the treatments.

Time of Application

Foliage sprays are restricted to the period of active growth after the leaves become full-size. Trunk base sprays are most effective if applied during the winter dormant period. They can be used during summer, but are less effective during the initiation of growth in the spring or other seasons. Cut-surface treatments are used generally over the entire year. Soil injections should be made only during early spring and during the period of maximum plant activity.

Experimentally, substituted phenyl ureas appear to offer considerable promise as trunk base sprays or broadcast in granular form over the soil surface. Blackjack and post oaks are equally susceptible, but some other associated woody plants are not so sensitive.

Before any of these treatments are applied more complete information should be obtained from publications listed below or other informed sources.

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Vernon A. Young

SCRUB OAK (Quercus turbinella Greene and/or Q. dumosa Nutt.)

Distribution and Description

The taxonomy of the scrub oak (Q. dumosa) or shrub live oak (Q. turbinella) is not consistent. Kearney and Peebles (2) separate Q. turbinella as a distinct entity in the Arizona chaparral. Jepson (1), on the contrary, lists Q. turbinella as a variety of Q. dumosa, which is found in the chaparral of southern California. For practical purposes, there is little distinction between the two plants other than their geographic distribution. Both are dominant in the chaparral of Arizona and southern California. The plant is a shrub or small tree up to 10 feet high forming extremely dense thickets with other chaparral species. Leaves are toothed and covered with a more or less whitened bloom.

Best Herbicides

Only a limited amount of chemical control research has been done on the mature stands of this species and it has been uniformly unsuccessful. Tschirley (7) reported on an aerial spray of chaparral in June 1953. The percentage defoliation on oak ranged from 0 to 40 percent for different treatments but no plant kill was recorded. More detailed work has been done on oak sprouts following fire. Leonard (3, 4, 5) reports that a brushkiller (1:1 mixture of 2,4-D and 2,4,5-T) in the chaparral type is recommended, because some species in this vegetation complex are more susceptible to 2,4-D than 2,4,5-T. He mentions also 2-(2,4-DP) and silvex looked promising in the California chaparral. Schmutz and Turner (6) sprayed oak sprouts with a number of different chemicals at various intervals following fire. They found that the low volatile ester of silvex was the best herbicide tested followed by the low volatile esters of 2,4,5-T and 2-(2,4-DP).

Two of the urea herbicides, monuron and fenuron, are being tested, but adequate information on their effectiveness is not yet available.

Rate, Volume, and Carrier

Apparently, high concentrations and high volumes are necessary to effect control even on the sprouts of oak. Leonard, in his work in California, used spray solutions as high as 4 lbs. active ingredient in 40 gallons of carrier. Schmutz and Turner used a concentration of 3.2 lbs/40 gals in their work. This was all hand-spray work, so the rates and volumes per acre cannot be accurately determined. The most efficient carrier, generally, is an emulsion of diesel oil and water. Leonard used 1 percent diesel oil in water, while Schmutz and Turner used a 1:10 S/V Sovaspray 100 (a nontoxic oil) in water ratio. A high-volume application was made in all cases.

Time of Application

The best time for treating sprouts is not exactly known. Leonard reported treatments on sprouts 2 years following a burn. Schmutz and Turner made 6 treatments, the first 3 months after a June fire and the last 12 months after the fire. Best results were obtained beginning 6 months after the June burn, at which time foliage was well developed and the winter rains had begun. After this date there was little difference in kill for dates of application with the best chemicals.

General Considerations

Chemical treatment by itself on mature plants is not considered feasible. Usually there is only a partial defoliation of the plants, and they produce new leaves very rapidly. The most promising practice seems to be the chemical treatment of sprouts following fire.

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Fred. H. Tschirley

SHINNERY OAK (Quercus havardii Rydb.)

Description and Occurrence

Shinnery Oak, a member of the Beech family, a small shrub; thicket forming; grows in sandy soil; spreads by underground stems, larger portion of individual plants being underground; propagation is by separation of the root stocks as well as by acorns. It occurs in the Southern Great Plains and the Southwest.

The large and sweet acorns are relished by livestock but this species has caused much poisoning. This plant acts as a physical barrier to good range management and competes unfavorably with desirable forage plants (1).

Chemicals for Control

Best control (2) has been over 90 percent when sprayed two or three consecutive years with 2, 4, 5-T (low volatile ester) or 2(2, 4, 5-TP) (low volatile ester).

Rate, Volume, and Carrier

Aerial Application: Most effective treatments have been one pound acid equivalent of 2, 4, 5-T or 2(2, 4, 5-TP) and three gallons of diesel oil per acre, applied three successive years.

An emulsion of one gallon of diesel oil and two gallons of water is equally as effective as diesel oil alone, but the emulsion requires proper equipment for continuous, violent agitation (3).

Airplane application of herbicides is a specialized job. Area to be sprayed must be flagged. Secure qualified technical guidance. Employ a reliable applicator who is licensed by the State Plant Board. Airplane spray equipment should be designed for low pressure to apply a coarse spray which results in large droplets. Spray early in the morning and late in the evening.

Ground Spraying: Most effective treatments have been one pound of 2, 4, 5-T or 2(2, 4, 5-TP) and five gallons of diesel oil per acre applied three successive years.

Time of Application

Effective applications are made only between the dates of May 15 and June 15. The plant should be making rapid growth during treatment.

General Considerations

The spray distribution must thoroughly cover the leaves, terminal buds and all growing stems of the plant. The air temperature should be moderate with high relative humidity, and wind velocity not exceeding 10 mph. Spot treatment with ground equipment may be necessary in the fourth year to secure complete eradication (2).

Grass production can be doubled for a period of 3 to 5 years by spraying Shinnery only one time with one-half pound of 2, 4, 5-T or 2(2, 4, 5-TP), but only about 20 percent of the brush is killed (2).

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Hurlon C. Ray

PINGUE (Hymenoxys richardsoni Hook)

Species, Description and Distribution

Pingue, which is often called bitterweed or Colorado rubberweed, is a member of the composite family. In many respects it resembles bitterweed (Hymenoxys odorata). Pingue is a perennial herb; stems tufted, 1-5 dm. high, branched above, glabrous or nearly so. Leaves alternate, mostly basal, divided into 3-5 narrow lobes, glandular-dotted. It is woolly at the base with dense cottony hairs between the axles of the lower leaves. Heads 1-2 cm. in diameter, numerous in flat-topped clusters, similar to Hymenoxys odorata. Pingue is long flowering and blossoms from the last of June to about the end of August. Some of the mature seed heads remain until late fall. This plant contains small amounts of intracellular latex.

Distribution and Habitat

Pingue grows mostly on grass lands and open forests on dry, sandy or gravelly soils. Its distribution extends from Saskatchewan on the north to the borders of Texas, westward to California, Utah and Oregon. In general its altitudinal range varies from 5,000 feet to 10,000 feet elevation in certain areas. This species has been reported to kill sheep in Texas but on close botanical classification, these deaths have been due to bitterweed mistaken for Pingue which extends only to the western border of this State.

Chemical Control

Herbicidal control has been practiced with varying degrees of success. Parker reports a 95.3% kill of Pingue plants when a 25% aqueous solution of Atlacide applied in a form of a spray of Pingue plants. This treatment would be too expensive under practical range conditions. However, certain investigators have shown that the best kills to date have been obtained with the esters of 2,4-D. Water solutions of concentration of 2 to 4% applied as wetting sprays or spray of 1-1/2 pounds of acid equivalent of 2,4-D in 25 to 50 gallons of water per acre applied with power equipment is recommended. More research with various chemicals would be desirable in the future.

Time of Application

Spray as soon as the first leaves are approaching normal size and flowers begin to develop. Thus little to no results are apparently obtained from spraying Pingue after the flowering stage.

General Considerations

Animals poisoned: Death losses in sheep from Pingue poisoning may occur any time during the year, but the most dangerous periods are the early spring and late fall on ranges of little desirable forage.

Poisonous nature and symptoms: Symptoms are similar to those of bitterweed (Hymenoxys odorata). Sheep which have eaten considerable Pingue are usually distinguished by a typical green discoloration about the mouth and nose, loss of appetite, walk with difficulty, and with arched backs. Severe cases show frequent coughing and sneezing which results in a green mucous secretion from the nose and mouth.

Control and management: There is no medical cure for severely poisoned animals therefore, as soon as animals show symptoms of poisoning they should be removed to clean or desirable pastures or put on feed. Good condition range will aid in controlling Pingue.

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Vernon A. Young

PRICKLY PEAR (Opuntia platyopuntia)

Description and Occurrence

Several species of prickly pear are associated with the title Opuntia Platyopuntia. The name Platyopuntia refers to the flat jointed species which are adapted to rather large grassland areas of the central and southern Great Plains of the United States. They vary in size from the rather low growing plants of central plains areas to huge plants common to given areas of south Texas. The two principle methods of controlling or eradicating prickly pear that grows on range lands are by grubbing and the application of chemical treatments.

Chemical Methods of Control

Chemicals normally used for control of prickly pear include the 2, 4, 5-T esters, mixtures of 2, 4-D and 2, 4, 5-T esters, silvex, sodium trichloroacetate (TCA), and dinitro compounds in diesel oil on kerosene or emulsions containing various ratios of water and oil. These chemicals may be used effectively for control of all forms of most prickly pear plants provided all the parts are thoroughly covered.

The chemical 2, 4, 5-T is commonly used in the treatment of Opuntia platyopuntia species in the Southwest and certain adjacent areas. Since the sale of this hormone-type herbicide is regulated by the law in certain states one should become familiar with the requirements relative to where and how it may be used.

Rates, Volume and Carrier

2, 4, 5-T solutions are usually explained in a descriptive write-up attached to the container in which it is sold. A one percent solution of 2, 4, 5-T in diesel oil has been most effective for controlling Engelmann and Nopal prickly pear in the Southwest. However, stronger solutions may be necessary in certain other locations.

Hand application of 2, 4, 5-T solutions with knapsack, compression tank-type and power sprayers have been most effective for prickly pear control. Pressures of 25 to 35 pounds for hand sprayers and 40 pounds for power sprayers are recommended. Large-size droplets are more desirable for covering prickly pear plants than small size or fog-like droplets. Both sides of the prickly pear pads, joints and fibrous trunks must be wet thoroughly to the point of slight runoff to obtain effective kill and control. Diesel oil or kerosene should be used with hand sprayers, while oil-water emulsion can be used in power sprayers equipped with agitators. Emulsion sprays are as effective as oil sprays if kept agitated but more volume of solution is required for treating individual plants. Use of emulsion will reduce the cost of treating prickly pear on large areas. Boom-type sprayers have not been as satisfactory in spraying the prickly pear plants in regions as those methods cited above.

Time of Application

During the hot summer months is usually the most desirable period for spraying the species Opuntia Platyopuntia.

General Considerations

Grubbing and piling of prickly pear is practical on many range lands and is usually done on a contract basis for $4.00 to $9.50 per acre depending on the species and the

density of the plants. The piles are often burned during the slack work season on many ranches.

Good range management practices are the key to prevent reinfestation of prickly pear on treated ranges. Otherwise the above treatments do not pay based on reliable trials in the Southwest.

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Vernon A. Young

RABBITBRUSH (Chrysothamnus viscidiflorus Nutt., C. nauseosus Britt., and Aplopappus bloomeri Greene--also called C. bloomeri Gray)

Description and Occurrence

These shrubs are most abundant within the Great Basin where they often dominate large areas. They are small to medium-sized shrubs of the open plains and foothills up to 10,000 feet elevation. Most of the species grow at comparatively low altitudes on fairly deep, heavy soils, but some are frequently a conspicuous component of the vegetation on alkaline plains and on sandy soils. C. viscidiflorus and C. nauseosus are extremely variable in appearance, and each includes about 20 varieties. Generally C. viscidiflorus has green herbage and C. nauseosus has gray herbage.

Chemicals for Control

Successful control has been obtained only with 2,4-D esters.

Rate, Volume, and Carrier

Apply 2,4-D ester at 3 lb/A in water with wetting agent (or other carriers if preferred) at a total volume of 5 gal/A after new twig growth exceeds 3 inches in length.

Time of Application

Nearly all successful treatments have been made in early June. Spraying may be accomplished after new twig growth exceeds 3 inches in length and when large bunchgrasses (such as bluebunch and crested wheatgrasses) are heading out. Earlier applications will kill the active growing tissue and stimulate lateral and basal sprouting. Effectiveness drops rapidly after soil moisture is depleted in the surface 10 inches, the herbage of sandberg bluegrass is losing green color rapidly, and after rabbitbrush begins flowering.

These spraying requirements may also be used to kill rabbitbrush and big sagebrush in mixed stands.

General Considerations

Root planing, burning, and plowing (in decreasing order of effectiveness) have been used for the control of rabbitbrush. Following such treatments new sprouts have been easily killed with 2,4-D.

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D. N. Hyder

MEDITERRANEAN SAGE (Salvia aethiopes L.)

Description and Occurrence

Mediterranean sage is a newly exotic plant supposedly introduced from North Africa. In 1948 it had occupied about 50,000 acres of depleted range in southeastern Oregon, but was not known to occur elsewhere in North America.

This is a biennial with very broad, hairy leaves that is not grazed by livestock or game animals. It has completely dominated stands of cheatgrass-filaree, but has moved tardily into perennial stands of big sagebrush and bunchgrasses.

Chemicals for Control

The materials used were esters of 2,4-D, 2,4,5-T, and MCPA, and the sodium salt of 2,4-D. There were no important differences among materials at an acid rate of 2 lb/A, but kills were very good with esters of 2,4-D at 1 lb/A.

Rate, Volume, and Carrier

Spray with an ester of 2,4-D at 1 to 2 lb/A in water at 10 to 20 gal/A during the active growing season.

Time of Application

Mediterranean sage should be sprayed soon after all new seedlings have emerged. Two important factors were noted which indicate the necessity for spraying in two or more consecutive years: (1) The large leaves of second-year plants protected seedlings growing underneath so that a few mature plants were found on plots the year after spraying, and (2) The scattered occurrence of seedling plants the following year indicated new introduction or retention of seed on the plots.

General Considerations

The competitive release obtained on sprayed plots permitted a good growth of cheatgrass and filaree. However, the best procedure for returning invaded areas to forage production involves the establishment of perennial bunchgrasses.

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Unpublished data in Squaw Butte-Harney Experiment Station files.

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BIG SAGEBRUSH (Artemisia tridentata Nutt.)

Description and Occurrence

Big sagebrush is a large shrub with silvery green leaves. The specific name refers to the three teeth at the apex of the leaf. It is the most widespread and most familiar species of Artemisia, and is probably the most abundant shrub in western North America.

Chemicals for Control

Both 2,4-D and 2,4,5-T are effective on big sagebrush. In the early portion of the growing season 2,4,5-T at 1 lb/A is as effective as 2,4-D at 2 lb/A. About 6 weeks later (if growing conditions remain favorable) 2,4-D is equally as effective as 2,4,5-T. There is no value to be gained by mixtures of the two materials on this species. Spraying with 2,4-D gives cheaper control than with 2,4,5-T at present prices.

Amine and sodium salt forms have been erratic and relatively ineffective when compared with ester forms. Among the esters there is but little difference in effectiveness at the rates recommended; however, butyl and ethyl ester forms are preferred rather than isopropyl ester. The low volatile ester forms are as effective as butyl ester.

Rate, Volume, and Carrier

2,4-D is applied at 1-1/2 to 2 lb/A and 2,4,5-T is applied at 1 lb/A. The practical range in solution volume is 3 to 10 gal/A. A composite of both lower limits is considered inadequate. Every leaf and stem must be killed to make a dead plant; therefore, in dense and leafy brush more material and volume is needed.

Water, oil-water emulsions, and diesel oil have been used successfully as carriers. There has been no clear cut advantage to any of these, but water is less expensive and diesel oil weighs about 7 lb/gal as compared with 8 lb/gal for water. The optimum volume with each carrier has been 5 to 6 gal/A. With water an additive is needed to improve wetting properties. Wetting agents may be added to the water at a rate of 0.1 to 0.5 percent by volume. In preparing emulsions the diesel oil has been included at the rate of 1/2 to 1 gal/A with water as the remainder of the carrier. The herbicide must be added to the oil then emulsified in the water.

Time of Application

Big sagebrush is easily killed at all times during the period of active growth. This period has been related to the developmental stage of associated grasses in May and/or June. The most widely used timing coincides with the flowering development of small bunchgrasses (such as sandberg and cusick bluegrasses) and the heading development of large bunchgrasses (such as Idaho fescue and bluebunch wheatgrass). The effective spraying season begins when the small bunchgrasses are heading and ends with soil moisture depletion in the surface 10 inches. Soil moisture depletion is indicated when the herbage of sandberg bluegrass is losing green color rapidly.

General Considerations

Spraying for the control of big sagebrush is recommended for the release of native forage on areas in fair to good condition. A three-fold increase in forage production is

common. Since many desirable forbs are killed by 2,4-D, it may be unwise to spray areas where such susceptible species are present (1).

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D. N. Hyder

SILVER SAGEBRUSH (Artemisia cana Pursh.)

Distribution and Description

Silver sagebrush differs from other species in that the most common type has an entire leaf. It usually grows on deep, fertile, moist soils. The sites occupied by silver sage usually represent high forage-producing potential.

Chemical

Ester of 2, 4-D

Rate, Volume and Carrier

Two pounds acid equivalent of an ester 2, 4-D in diesel oil at 3 gallons of solution per acre has given good top kills when applied by airplane. Resprouting has often occurred, however, and appears to coincide with the earlier spraying.

Two pounds of an ester 2, 4-D per acre is recommended. Water, and diesel oil are satisfactory carriers. For aerial application, 3 to 5 gallons of diesel oil per acre or 5 to 6 gallons of water or oil-water emulsion per acre are indicated. At least 10 gallons of solution volume should be used with ground application to insure uniform coverage. Proper timing is essential. The butyl ester of 2, 4-D has been the form of 2, 4-D most widely used.

Time of Application

Spray should be applied when new twig growth is 3 to 4 inches. This usually coincides with the heading out of large bunchgrasses such as bluebunch wheatgrass or crested wheatgrass. If big sagebrush is to be sprayed at the same time, spraying should be done near the end of the effective spraying period for that plant.

General Considerations

Spraying should be followed by two to three years of complete rest from grazing.

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William A. Worf

FRINGED SAGEWORT (Artemisia frigida Willd.)

Description and Occurrence

This plant is also called estafiata, Artic sage, and mountain wormwood, and in Canada it is called pasture sagebrush. The name fringed sagewort or fringed sagebrush, is appropriate since the leaves are very finely divided and rather downy. It is a perennial and is adapted widely to the arid and semi-arid plains and mountains of the western United States.

Stems are from 2 to 24 inches in height, the composite flower heads are globe shaped and borne on a rather straight, slender stem, which is woody at the base and often much branched there. The stems are erect, rather leafy and densely haired. The plant has a "sagey" fragrance.

Fringed sagewort increases in grasslands grazed by cattle to a point where production of palatable forage is substantially reduced.

Chemicals, Rates, Volume and Carriers

Experimental work on control of fringed sagewort has been very limited. What little information is available is not of a quantitative nature. Incidental to loco control, applications in Montana where 2,4-D was applied in water and in oil at the rates of 1 to 3 pounds per acre, substantial reductions in the stand of fringed sagewort were noted. These applications were made during the early part of the growing season when white point loco was in the early growth stage. Also incidental to big sagebrush control operations, good control of fringed sagewort was obtained where aerial applications of 2 pounds per acre of 2,4-D in oil and water were applied from an airplane.

General Considerations

Fringed sagewort has been found to be palatable and nutritious to sheep on winter range in Montana. On such range and possibly in other instances, it might be a desirable plant and control would not be indicated.

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Karl G. Parker

Salt Cedar (Tamarix pentandra Pall.)

Description and Occurrence

Salt cedar is a large shrub or small tree with slender branches. The branches are covered when young by small, scale-like leaves. The pink or nearly white flowers are born on slender spikes at the ends of branchlets. The specific name pentandra refers to the five stamens characteristic of the flowers. Salt cedar is distributed across the southern half of the United States and in the Pacific Coast States. It has recently been found in Wyoming. The spread of this species since its introduction into the United States indicates that it can extend its range much beyond its present limits. Salt cedar flourishes on river flood plains and along irrigation systems.

Chemicals for Control

Esters of the phenoxy herbicides have been better than amines in all cases. Of the phenoxy herbicides 2, 4, 5-T is more effective than 2, 4-D(1, 2, 4, 5) and there are indications (3, 4, 5) that silvex will be still more effective.

Rate, Volume and Carrier

Rates of less than 2 lbs/A have generally given poor results. The latest information (3) indicates that rates of 4 lb/A of silvex are necessary for good control.

There is little information available regarding volume and carrier. Aerial applications using 5 gpa volumes (4) and ground applications using 60 gpa volumes (1) have been used, but not in comparable studies. Diesel oil: water emulsions and a water carrier have both been used, but no mention is made of which is the better.

Time of Application

Salt cedar becomes increasingly more resistant with time. Arle and Bowser (2) found that applications of 2, 4, 5-T resulted in almost complete kills on seedlings 3-11 months old, but treatments were much less effective when seedlings were 25 months old. Similarly, results were much better on six-month-old regrowth than on 25-month-old regrowth.

Mechanical clearing or burning followed by repeated spraying of the young regrowth appears to be the most effective method now known for controlling salt cedar.

General Considerations

Repeated treatments are necessary to kill salt cedar. Temporary defoliation and partial plant kill results only in a very rapid re-infestation of the area. Salt cedar is more difficult to kill on flood plain situations than along irrigation channels and streams. Mechanical methods of control are expensive but useful in areas near cotton or other crops susceptible to phenoxy herbicides.

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Fred. H. Tschirley

SAW-PALMETTO (Serenoa repens [Bartr.] Small)

Description and Occurrence

Saw-palmetto, the most common of our native palms (1), occurs from the Florida Keys to Louisiana and South Carolina. The robust stems of this large evergreen shrub characteristically are horizontal and creep just under or at the surface of the ground. If not kept down by burning, short erect trunks may form; these may branch and become a tree up to 25 feet tall. In the procumbent form stems branch frequently. They form a tangled mass with the leaf crowns arising above them to form an almost impenetrable thicket. Saw-palmetto's immense colonial aggregation frequently covers large acreages with thousands of individual specimens living in close proximity.

Chemicals for Control

Nation (4 and 5) reports good kill with isopropyl ester and polypropylene glycol butyl ether ester of 2, 4, 5-T. Sodium trichloroacetate (TCA) also gave good results. When used alone, 2, 4-D was ineffective but could be used to replace some of 2, 4, 5-T in a mixture.

In northwest Florida, Grelen (3) got effective kills with both propylene glycol butyl ether and butoxy ethanol esters of 2, 4, 5-T.

Cassady (2) indicates individual plants may be killed by injecting ammate (ammonium sulfamate) into the bud or stems and following with a spray of the same chemical on the bud and new growth.

In screening tests at Olustee, Florida (6), spray applications of the following chemicals were ineffective: ammonium sulfamate, ammonium thiocyanate, methyl ester of 2, 4-D, pentachlorophenol (PCP), and kerosene.

Rate, Volume and Carrier

Most effective rates reported by Nation (4 and 5) were 5 to 6 pounds acid equivalent of polypropylene glycol butyl ether ester or isopropyl ester of 2, 4, 5-T per 100 gallons of water, or the same amount as a mixture of equal parts 2, 4, 5-T and 2, 4-D. Oil apparently increases the effectiveness of these chemicals. With 10 gallons of oil in 90 gallons of water, 2 to 3 pounds acid equivalent of 2, 4, 5-T appear sufficient.

Rate trials for TCA are limited but 1/2 pound to 1 gallon of water is recommended.

For all the above chemicals it is important to spray foliage until thoroughly wet. No set figure can be given but 100 to 150 gallons of solution per acre is suggested.

With ammate, inject 1 to 4 tablespoonfuls into growing and conducting tissue; spray new growth with 32.5 percent ammate solution (4 pounds added to 1 gallon of water).

Time of Application

If saw-palmetto is cut off, spraying should be delayed until sprouts are six months old or until a majority of potential buds have sprouted.

Best time of spraying is not known. Most effective treatments in central Florida were from October to December; June applications were nearly as effective but results

in March were poor. More recent trials in northwest Florida by Grelen (3) indicate that higher concentrations (3-1/2 - 4 pounds, 2,4,5-T per 100 gallons of water) were equally effective from January through September.

Ammate is probably least effective in spring.

General Considerations

Chemical effects should not be assessed until 1 or 2 years after application. Results are faster and more conclusive when chemicals are used in open areas.

Mechanical measures are widely used on relatively high-value land. Generally this is too expensive and impractical for eradication and control when land use is mainly for grazing and timber production. Chemicals appear promising but expense still restricts their use. More efficient and economical measures are sorely needed.

Abundance of this palm has long constituted a challenge for someone to make profitable use of the leaves and trunk. Leaves have been manufactured into paper of poor quality. Trunks have been processed to serve as a cork substitute for floats and gun plugs. The conducting bundles in stems represent a potential source of fibers.

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Lowell K. Halls

WILLOWS (Salix spp.)

Description and Distribution

Probably no other Angiosperms are more commonly associated with water than the willows. Several hundred species are found in the north temperate and subarctic regions. They are generally distributed over the United States wherever there is an adequate supply of water to support their growth. Commercially, the willows are of little importance. They do have a place in prevention of stream bank erosion, however, and have some horticultural use in parks and gardens. They are also utilized as browse for big game animals in winter range and are taken to some extent by domestic livestock. In the field of range and pasture management, willows encroach on hay meadows, and where water is in short supply, become a problem in water usage. Elsewhere, they are a brush problem and are often controlled in a general brush control program set up to kill other species at the same time.

Chemicals

An ester of 2,4-D has been found effective as a foilage spray for both aerial and ground equipment (1, 2, 4). For cut surface treatment, an amine salt of 2,4-D (4), or a mixture of 2,4-D and 2,4,5-T (1) available as a commercial "brush killer" may be used. For basal treatment, ester formulations of 2,4-D or "brush killer" is recommended (4).

Rate of Application, Volume and Carrier

Foliage spray: As a treatment for individual plants, 2 to 3 lbs. of an ester of 2,4-D per 100 gallons of water or water plus 1% diesel oil applied in an amount to wet foliage has been found satisfactory. For aerial application, 2 to 4 lbs. ester of 2,4-D in 5 to 10 gallons of water or fuel oil is recommended. At the higher gallonage, water plus 2-1/2 percent diesel oil has proven satisfactory.

Basal sprays: One lb. of ester of 2,4-D or "brush killer" in 6 gallons of diesel oil applied near the ground to the point of runoff should be used.

Cut surface: A "frill" or girdle, made with hatchet cuts around the base of the tree, should be filled with undiluted amine formulation of 2,4-D. Freshly cut stumps can be treated by painting or spraying to the point of runoff the cut bark and about 4 inches of the sapwood with 1 lb. of 2,4-D or "brush killer" in 6 gallons of diesel oil.

Time of Application

Foliage spray: Spring and summer after leaves are fully expanded and when soil moisture is not limiting.

Basal spray: Any time of the year, but winter and spring are preferred.

Cut surface and stumps: Effective at all times, but best results are had from November through May.

General Considerations

The reaction of willows to herbicidal treatment varies from species to species. Comparison of a compilation of results by Leonard (3) indicated that in most species where a

100% topkill was obtained, there was rarely a 100% root kill, and retreatment will most likely be necessary in an effective control program.

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W. C. Robocker

GENERAL INFORMATION ON HERBICIDES AND AERIAL APPLICATION FOR HARDWOOD SUPPRESSION

Both the high-volatile and low-volatile esters of 2,4,5-T, 2,4-D, and 2,4,5-TP have been used. The invert formulations of 2,4-D and 2,4,5-T are now being used on trial basis in the south and southwest. These formulations are showing some promise when applied by airplanes using special designed equipment. The high-volatile esters used are methyl, ethyl, propyl, butyl, and pentyl. The low-volatile esters used are isooctyl, butoxy ethanol, tetrahydrofurfuryl, and propylene glycol butyl ether ester. With favorable moisture conditions the 2,4,5-T amine appears to be almost equal to 2,4,5-T ester. However, 2,4,5-T amine is not as consistent as 2,4,5-T ester.

Work is now underway using substituted phenoxy urea herbicides. The mode of action of these herbicides provides a new and fundamentally different approach to the control of woody plants. Substituted phenoxy urea herbicides are applied to the soil surface and subsequently are absorbed by the roots of the plants and translocated to the aerial parts of the plant, where toxicity is expressed. The symptoms of this toxicity are typically a chlorosis of the foliage, which is followed by necrosis of leaf parts and finally by leaf abscission and defoliation of the plant. These changes take place slowly, and are progressive throughout the growing season. Several seasons usually are required to kill most woody plants of any size.

Of considerable interest in the field of brush control with chemicals is the current work underway with 2,4-D and 2,4,5-T in pellet or grandular form. The pellets are applied to the surface soil, and the chemical is moved to the root zone by rainfall. This type of application has great possibilities in aquatic weed control with an application of 100 pounds per surface acre of water.

The herbicides which are useful in aerial application must be effective in small quantities and must be adaptable to low-volume application. The herbicides act as growth regulators or as synthetic growth substances and when applied to a plant they can move and affect other parts of the plant. The movement is determined largely by the growth activity of the plant at the time of application. Since it has been determined that the chemicals generally move with the food materials of the plant, it is important to aerial spray when the leaves are fully developed, expanded and are beginning to manufacture food materials in excess of the requirements for the growth. Applications made too early will burn the leaves, but will not give proper kill to the plant. Applications made later in the summer after the growth has slowed down are not as effective. With all types of aerial application, best results have been obtained when the equipment has some type of pressure pump. The pressure behind the spray seems to give an even, controlled flow and good atomization. The orifice outlet faces rearward to give a coarse droplet.

Behind every good aerial spray job is planning, which includes flagging. Permanent and swath flagging is difficult in some areas because of the terrain, height of trees, and type of brush. Adequate flagging has been one of the most important factors. Many types of flagging have been used including: balloons, smoke pots, flags in trees, radios, and so forth. At the present, the best flagging is done by placing the flags in tree tops fastened to 20-30 foot cane poles, the permanent flags being spaced every ten swaths, or 260 feet. With this type of permanent flagging, it is best to use the colors of white, yellow and orchid.

Experienced swath flagmen are essential. They must get to their next station before the pilot is ready to line up for his next pass. Most flagmen use three-foot squares of white cloth atop cane poles, which are mounted on aluminum tubing. In addition to insuring good coverage, proper flagging will enable the pilot to make quick checks on the volume of material per acre that is being applied.

Airplane application appears to be the only feasible method for applying spray rapidly and economically on large areas of moderate to heavy brush. Also, airplanes can operate when it is too wet for ground sprayers. Aerial application of chemicals for brush control is a very sensitive operation. Good results are obtained only when all phases of the operation are carried out correctly. The important factors in a proper aerial application include the following:

1. Study of the area to be sprayed
   a. Soil types (Higher the site index of trees, more difficult the kill)
   b. Types of woody plants
   c. Purpose of spraying -- such as timber stand improvement, or brush control on range or pasture land
2. Time of day -- early morning, late evening
3. Time of year -- May, June, early July
4. Temperature -- 65° - 80°F.
5. Wind -- less than 5 miles per hour
6. Humidity -- high
7. Soil moisture -- favorable for plant growth at time of application and for several weeks following application
8. Proper spray system on aerial equipment
9. Pilot trained in aerial application of herbicides for control of brush
10. Area properly flagged with permanent flags, and trained flagging crew
11. Reliable chemicals and carrier, mixed correctly

Number 2 diesel oil is the principal oil used as a carrier for the ester formulations. Oil-water emulsions prepared with emulsifying agents also give effective and economical carrier solutions. Some work is now underway using non-toxic oils as a carrier. A formulation containing a new emulsifier is now being used that permits mixtures in straight oil without the difficulties of the emulsifiers settling to the bottom of the spray mixture.

The herbicides are not directly toxic to man, livestock, or the soil. Extreme care should be used in applying the herbicides. They drift readily and are injurious to cotton, legumes, fruit trees and many other broad-leaf plants.

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